Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

OCTOBER, 1958

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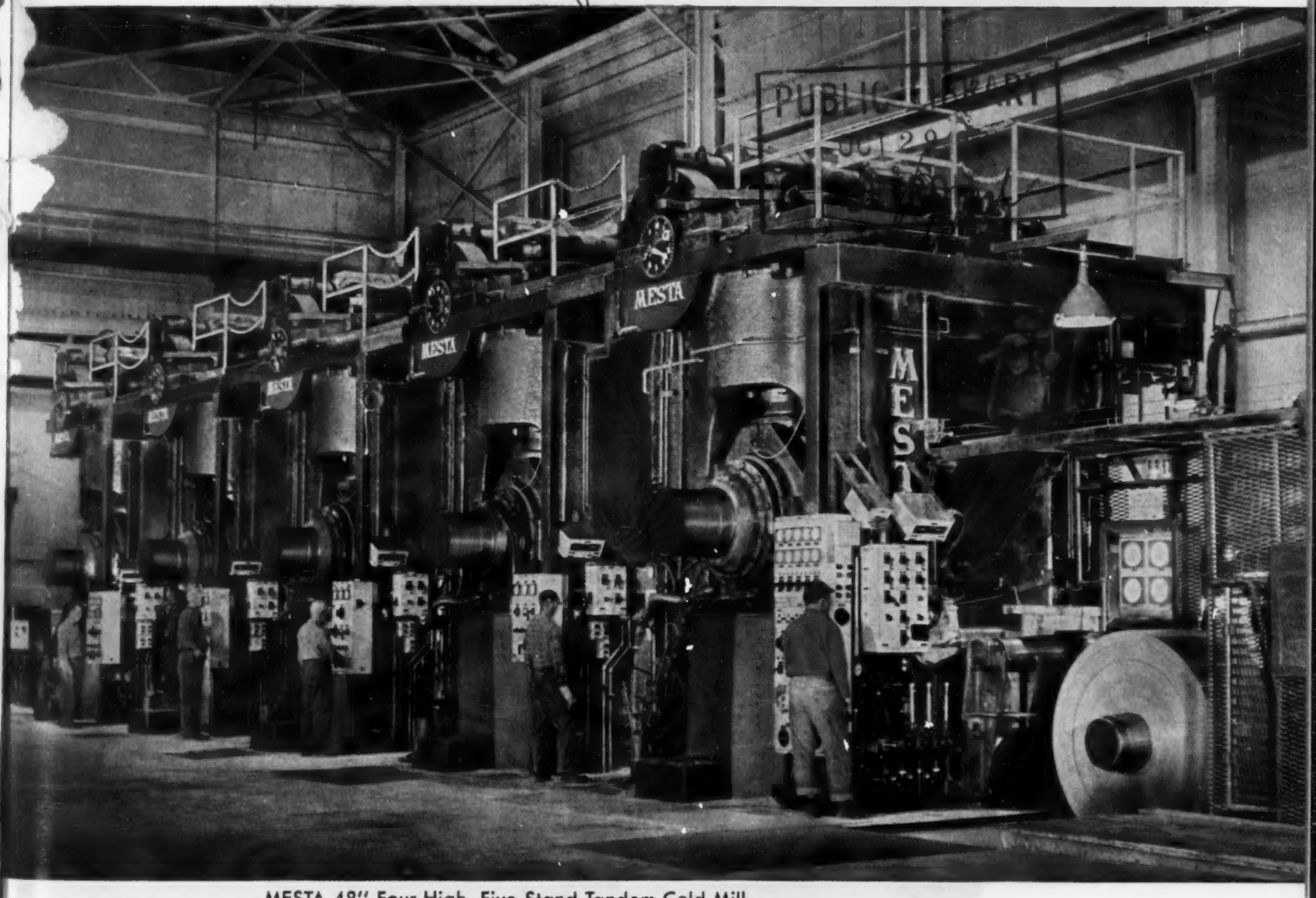
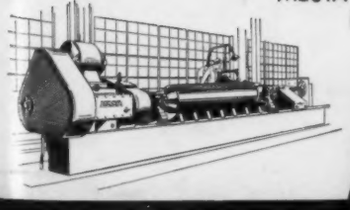
MESTA Cold Mills



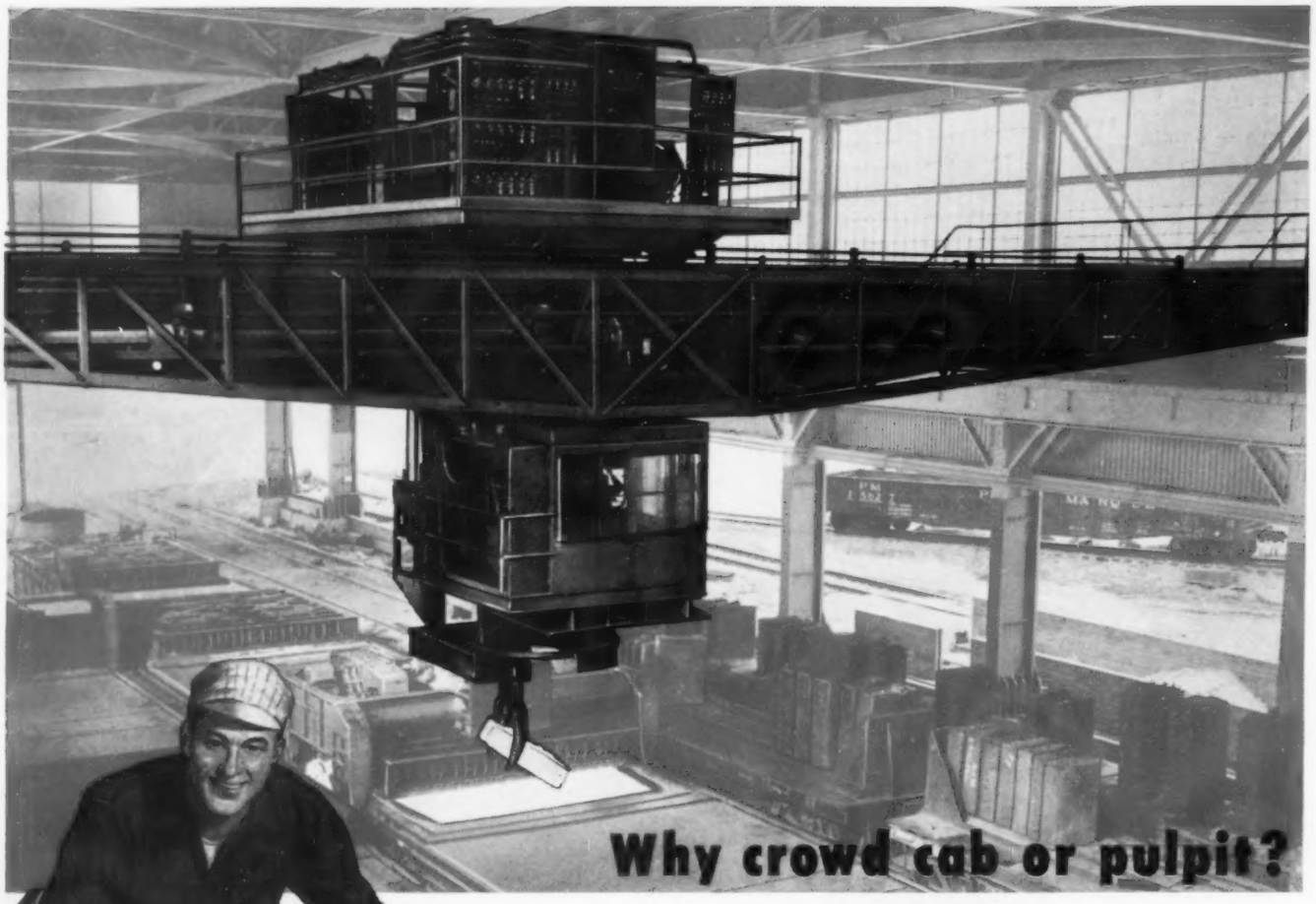
MESTA 48" Four-High, Five-Stand Tandem Cold Mill
Rolling Strip Steel for Tin Plate in Coils



Designers and Builders of Complete Steel Plants

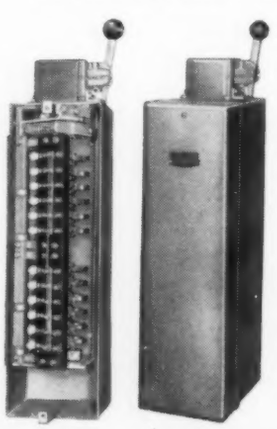
MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA



Use the "THIN" Master

The Cutler-Hammer 14951 Type D Master Switch is designed especially for crane cab and mill pulpit use where space is at a premium and dependable "pin-point" control is so necessary. Compact in design yet so easy to install and service. The Cutler-Hammer "Thin" Master employs the basic principles of design and construction that have been tested and proved over many years of service in the metal working and allied industries. Save space . . . save installation and wiring costs . . . save operator fatigue. Specify Cutler-Hammer Thin Masters for precise control, dependable control. For detailed information, write for Bulletin 14951-U232. Cutler-Hammer Inc., Milwaukee 1, Wis.



- **Compact in design . . . only 7⅜″ wide**
- **Lever head can be rotated in 90° steps for greater operator efficiency**
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- **Double break silver to silver vertical contacts individually removable**

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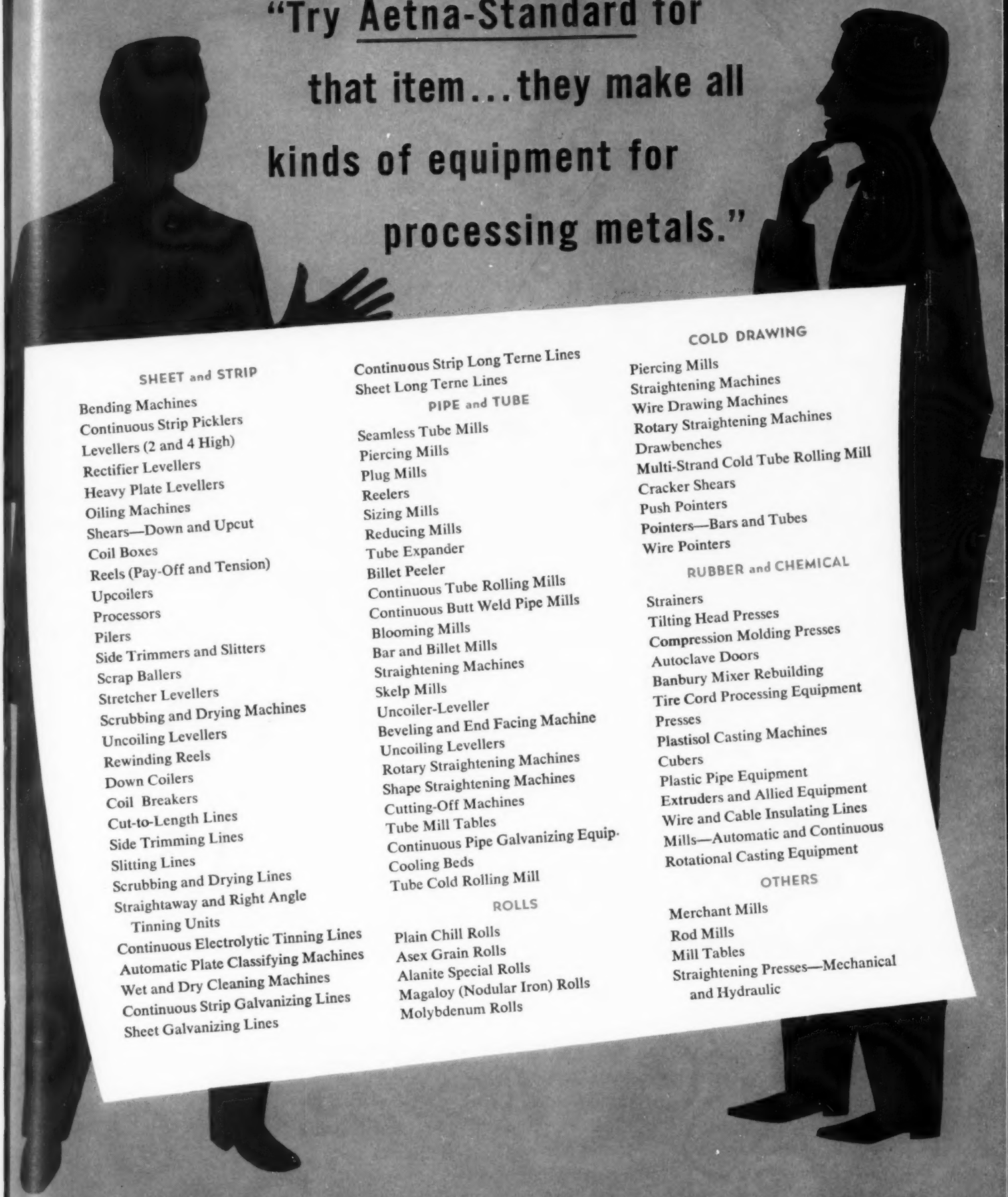

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Straightening Machines
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Multi-Strand Cold Tube Rolling Mill
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News and Notes on...

Good Packing Practice

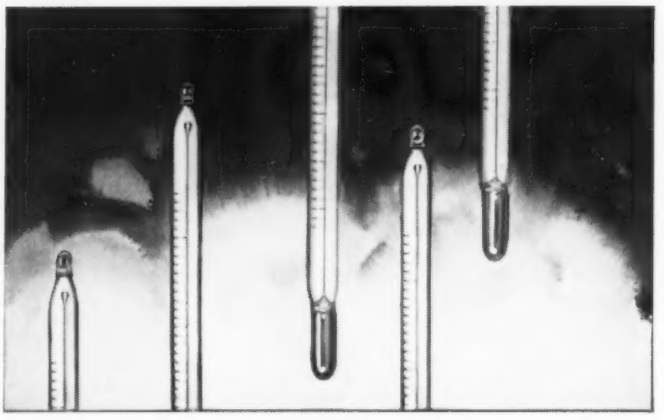
JOHNS-MANVILLE JM PRODUCTS

Maintenance and Design Hints from Johns-Manville Packings and Textiles Dept.

Subject of the month: High Operating Temperatures

Question:

What sealing materials are currently available that will match conditions brought about by higher and higher operating temperatures?



Condition 1

FOR LASTING VALVE SEALS AGAINST SUPER-HEATED STEAM AND DRY GASES

Designed to meet today's demand for a packing that will maintain a tight seal against steam and dry gases on valves working at line temperatures up to 1200F, J-M High-Temperature Valve Stem Packing, Style 397, offers the three-way protection of a heat-resistant plastic core, asbestos yarn, and Inconel wire reinforcement. For lasting protection of valve stems during storage, this efficient packing is now available with J-M No. 9 corrosion inhibitor.

Condition 2

FOR UTILITY SEALING IN GENERAL APPLICATIONS REQUIRING HEAT AND FLAME RESISTANCE

Wherever your operation calls for a utility gasketing material that withstands both heat and flame, specify J-M Asbestos Rope, Style 4200. Made of 99% pure asbestos, this material can take temperatures far in excess of other grades of rope. You'll find it a handy, reliable gasket for sealing joints between furnace doors and brickwork, boiler expansion joints, blast furnace connections, ingot moulds, and countless other uses. Ask for information about J-M Style 4200 Asbestos Rope.

Condition 3

FOR FLANGES WORKING AT TEMPERATURES TO 1600F AND HIGHER

Elevated temperatures are efficiently sealed using J-M Goetze V-Tite Gaskets. Used in flanges grooved for ring joint gaskets. Materials are available for service ranging upwards of 1600F. Controlled hardening assures correct flow of material at low bolt stress. Temperature range —320F to +1600F and higher.

Condition 4

FOR PACKING PROBLEMS IN ANY TEMPERATURE RANGE

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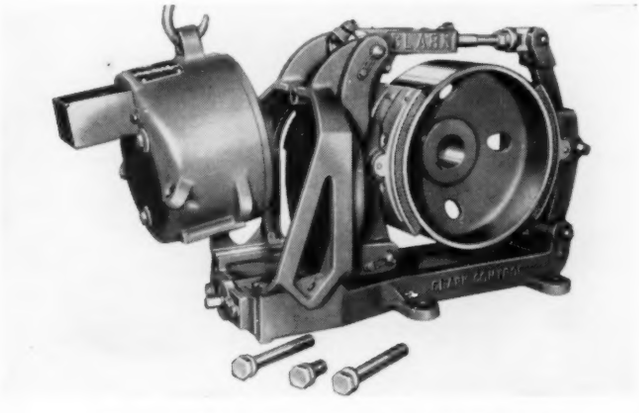
For information on any Johns-Manville Packings and Gaskets, write Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

JOHNS-MANVILLE

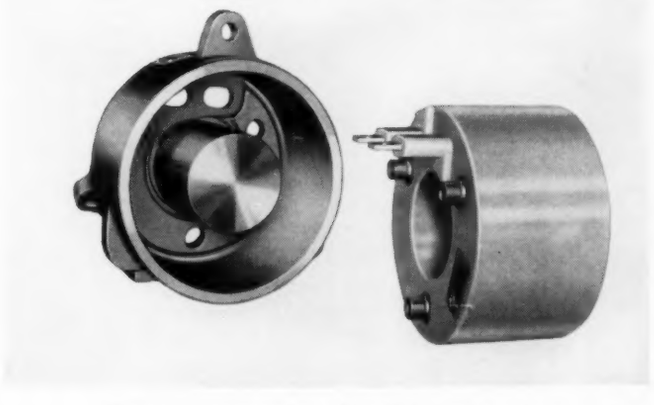
You can HOLD THE LOAD while you change coils on CLARK DC BRAKES

Photo Courtesy of Cleveland Crane & Engineering Co.

On the new improved line of Clark AISE-NEMA DC Magnetic Brakes, you can remove and replace the magnet case and coil as a unit, without releasing shoe pressure or disturbing any brake adjustment. ***Full torque remains applied to the wheel at all times.*** This exclusive feature is particularly important for added safety and convenience on crane applications, especially when loads are being carefully spotted or are suspended over areas where lowering is impractical or impossible.



By removing 3 bolts, magnet case and coil can be removed on the job without disturbing any other part of the brake. Full torque is maintained.



Epoxy-encapsulated coil is easily removed from magnet case by loosening 3 retainer bolts (4 on larger sizes) allowing coil to slide out.

Clark AISE-NEMA Brakes are now available in 5 sizes, from 10" to 23". For complete information, write for Bulletin 106-B.

The **CLARK CONTROLLER** *Company*

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		Max. Cable Dia."	Number of Conductors in one Cable			Max. Cable Dia."	Number of Conductors in one Cable			Max. Cable Dia."	Number of Conductors in one Cable			Max. Cable Dia."	Number of Conductors in one Cable		
COND. SIZE		Table 11 N.E.C.	ROCK PNR	3/64"	4/64"	Table 11 N.E.C.	ROCK PNR	3/64"	4/64"	Table 11 N.E.C.	ROCK PNR	3/64"	4/64"	Table 11 N.E.C.	ROCK PNR	3/64"	4/64"
½"	New Work	.450	2-4			.243				.234				.195			
	Rewiring	.479	2-4			.276				.252				.218			
¾"	New Work	.598	5-7	2-3		.323				.311				.260			
	Rewiring	.636	5-8	2-4	2	.367				.335				.290			
1"	New Work	.762	8-14	4-7	2-4	.412	2-3			.396	2						
	Rewiring	.811	9-16	5-8	3-5	.468	2-4			.427	2-3						
1¼"	New Work	1.000	15-19	8-12	5-8	.543	4-5	2-3		.523	3-5	2-3					
	Rewiring	1.070	17-19	9-16	6-9	.618	5-8	2-4		.564	4-5	2-3					
1½"	New Work	1.170		13-19	9-12	.634	6-8	4	2	.610	6-7	4					
	Rewiring	1.248			10-14	.721	9-11	5-7	2-4	.658	6-9	4-5	2				

This is an excerpt from the Rockbestos Control Cable Conduit Fill Chart covering sizes A. W. G. 9, 12, 14. Write today for your free copy. Ask for PNR 1-58.

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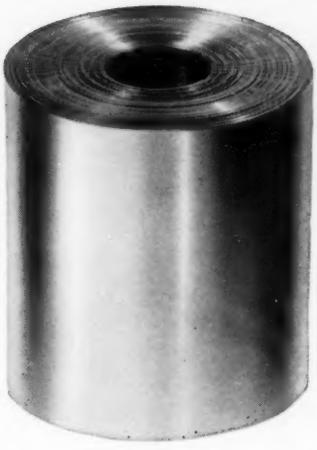

To anneal it better... faster...

.....open it up....

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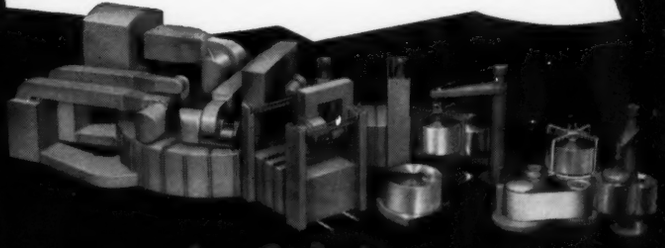

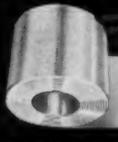

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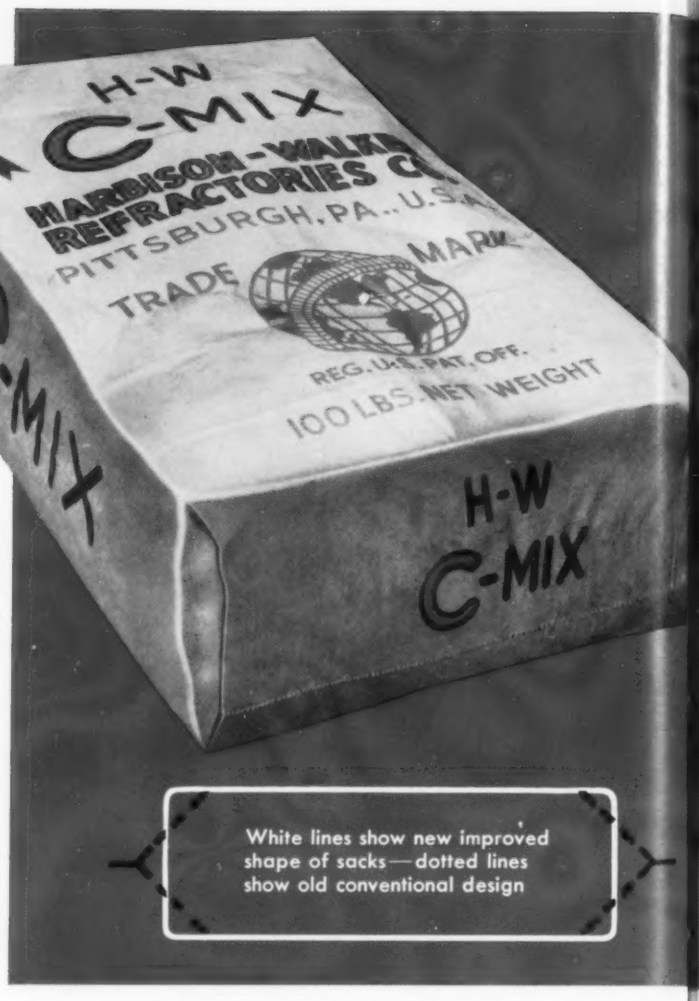
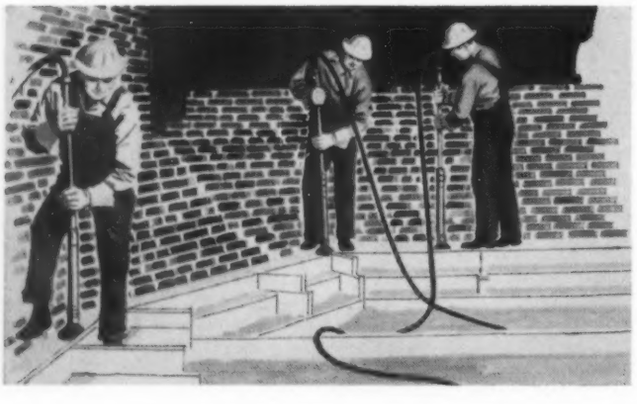
C-MIX and MAGNAMIX



H-W C-MIX (high purity seawater periclase) used for contour-rammed open hearth and electric furnace bottoms greatly reduces furnace downtime, saves labor and avoids burning-in sacrifice of refractory superstructure. And with its measurable margin of superior properties, costs are decidedly lower and furnace availability is greatly increased.



HIGH MAGNESIA CONTENT — Made from high purity seawater periclase with the magnesia content over 92%, H-W C-Mix best withstands the corrosive action of highly basic slags.

STABLE — It is fully converted to periclase and has excellent volume stability with negligible shrinkage at highest operating temperatures.

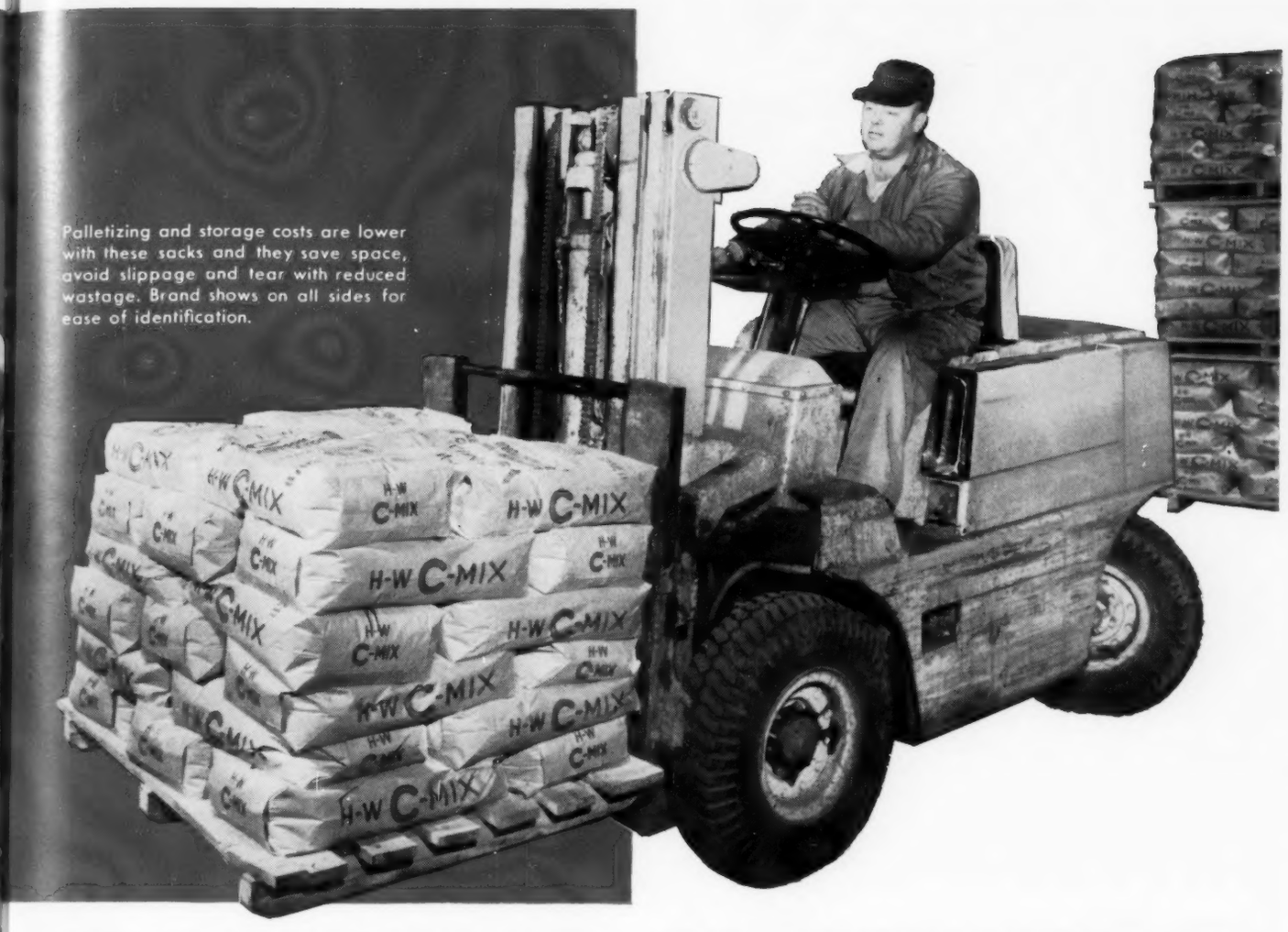
HYDRATION RESISTANT — H-W C-MIX is unique in its high degree of resistance to hydration.

STRONG — High strength over the entire range of steel furnace temperatures accounts for its excellent resistance to erosion.

DENSE — High density and low permeability retard penetration by molten metal and corrosive slags.

ECONOMICAL — H-W C-MIX provides the most durable monolithic hearths with low installation costs.

World's Most Complete Refractories Service



Palletizing and storage costs are lower with these sacks and they save space, avoid slippage and tear with reduced wastage. Brand shows on all sides for ease of identification.

RAMMING MIXTURES

H-W MAGNAMIX of 80% magnesia content stabilized as periclase, is made from dead-burned Washington magnesite. It is particle-sized to secure maximum density. While H-W MAGNAMIX is dependable for making new bottoms, it is especially adapted for bank maintenance, patching deep holes and repiping tapholes. It sinters into a hard dense monolith in a very short time at approximately 1000° F. lower than operating temperatures.

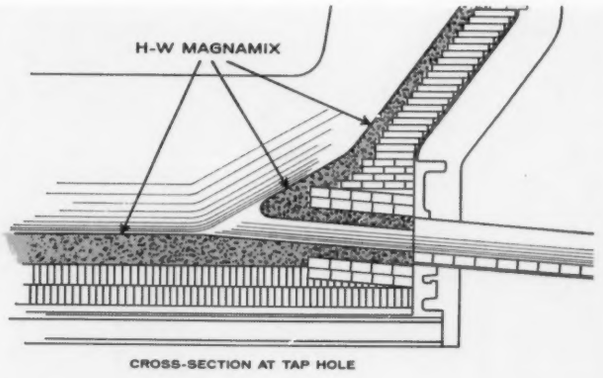
HIGH MAGNESIA CONTENT — It is used without the addition of slag or scale, thus avoiding dilution of its high magnesia content.

DENSE — As rammed into place, it becomes exceedingly dense and impermeable. When heated to operating temperatures, its density is further increased and a homogeneous monolith is formed.

STRONG — H-W MAGNAMIX has a strong cold set with the unusually high crushing strength of 1500 psi.

DURABLE — Its excellent resistance to erosion accounts for its splendid records and wide adoption in taphole service.

EASY TO USE — It has superior properties for patching large holes in banks and bottoms, and is applied by air-ramming, gun placement or by hand in hot patching.



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HARBISON-WALKER REFRACTORIES COMPANY

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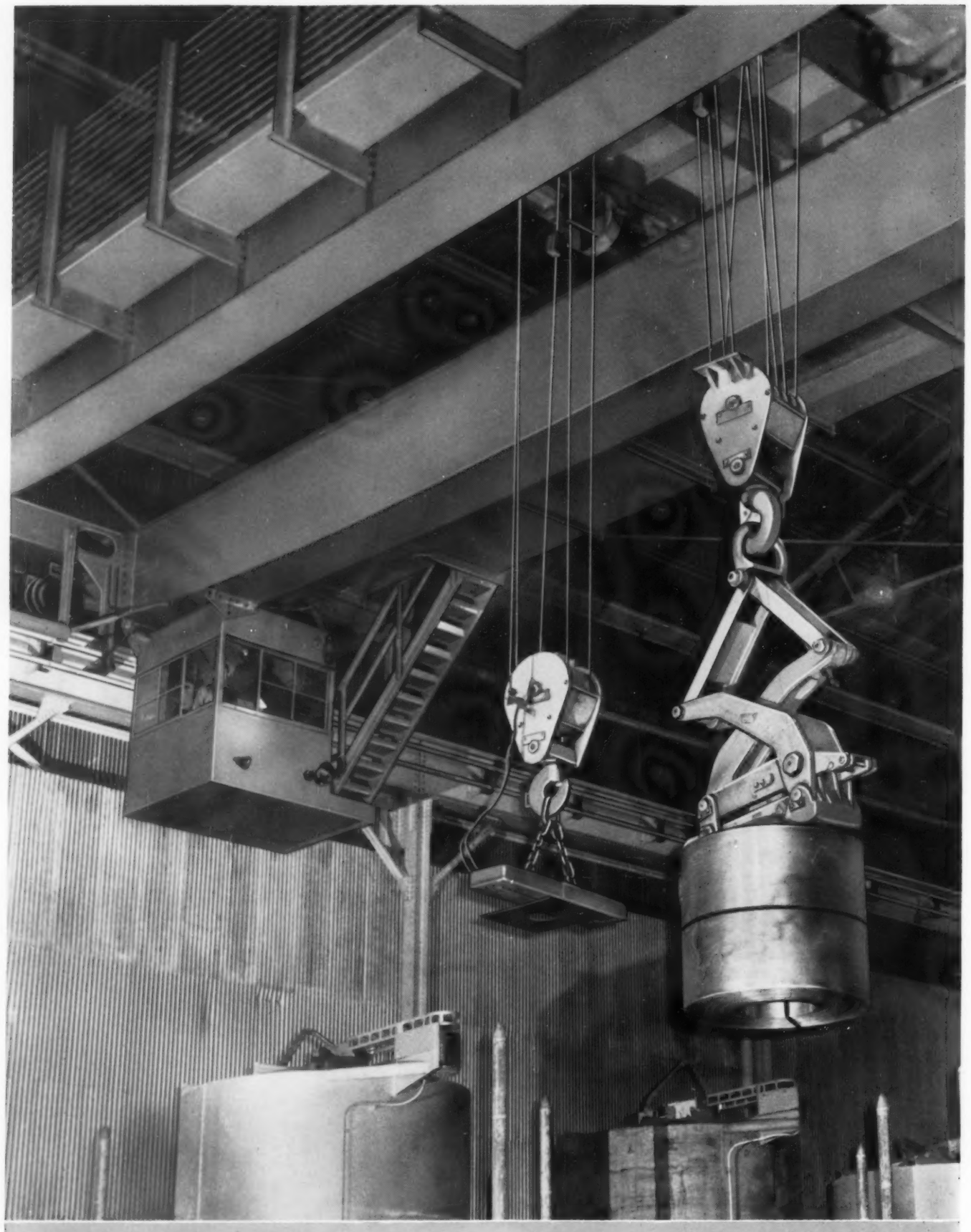


CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

THE CLEVELAND CRANE & ENGINEERING CO.
5031 EAST 289th STREET • WICKLIFFE, OHIO

Crops *and* Shorts

△ Early this year, when plans were being developed for the 1958 AISE Convention and Iron and Steel Exposition, some concern was expressed over the very low operating rate of the steel industry. Fortunately, steel business improved—and perhaps even more fortunately, AISE activities have come to be accepted as a valuable and essential part of the industry's development of key men and improvement of operating efficiency.

At any rate, the 1958 affairs in Cleveland were decidedly successful. The Exposition contained 47,183 sq ft of paid booth space, 8 per cent above 1956. Attendance, tallied by the Cleveland Convention Bureau, totaled 13,673, just 67 more than in 1956. Technical sessions were well attended and interest was high.

It takes a lot of work to plan and execute a large convention and exposition, and AISE extends heartfelt thanks to all who helped to make these so successful.

△ According to the American Iron and Steel Institute, the average hourly payroll cost for wage earners in the iron and steel industry hit a new high in July at $3.248, not including more than 33 cents for pension, social security and insurance. This is a result of the increases that went into effect in July in accordance with the current three-year agreement.

Prior to July, the first two years of the current contract had added about $680,000,000 to the industry's employment cost. This increase stemmed from an average increase of nearly 35 cents per hour in straight time, 12 cents in cost-of-living adjustments and about 14 cents in increased cost of pensions, insurance and unemployment benefits. The July, 1958, increase added approximately 20 cents more, making a total increase of about 80 cents over the three years.

△ Some statistician figures (where he got the data we'll never know) that the world's people spend five times as much gambling as the United States spends on foreign aid. He overlooks the fact that in gambling both sides have a chance.

And if foreign aid is gaged by our friendship abroad, we'd better stick to gambling.

△ Credit cards, variously described as "universal," "worldwide," etc., have enjoyed a field day in recent years. Their popularity seems to spring from the idea that such charges are easier to explain to tax people—or perhaps to the boss. They cover all forms of transportation, hotels, food establishments, florist, department stores, gift shops, etc. Organizations starting or getting into the game include commercial enterprises founded especially for the purpose, hotel chains, travel concerns, etc.

Maybe the service is worth the cost, but the public should realize this cost is not merely the five dollars or so per year each individual pays for his card. The real cost is hidden in the five or seven per cent that the credit agency collects on all billings. Needless to say, this cost is going to be passed on, not only to those using the service but to all patrons of the establishments belonging to the system.

If this thing continues to grow, we're going to consider forming an organization to ask for a discount for cash from member companies of all credit groups.

△ This year marks the 50th anniversary of by-product coking in the United States, which began in 1908 at Joliet, Ill.

△ Did you hear about the mountaineer who put a silencer on his shot gun because his daughter wanted a quiet wedding?

△ Eight large sinter plants, costing approximately $105,000,000, going into operation in 1958 will increase the steel industry's capacity to about 60,000,000 tons per year.

△ Detroit auto builders claim that Americans are gadget-happy. To satisfy this desire, the manufacturers have gone beyond power steering, power braking, power windows and power seat adjustment and are thinking about power-operated luggage compartment lid, power-operated doors, power-operated hood, power-operated sliding tops, power-operated vibrators in seats, all actuated by push-buttons on the dash. Of course, all these things will cost money, and manufacturers and dealers will make more money.

There was a time when we'd have sworn the buying public would rebel at these things, but after watching them swallow (with only minor choking) the absurd lengths, widths, lack of height, high horsepowers, pretzel-bending entries and exits, clusters of lights, grotesque fins, etc., we're not so sure.

△ Better get one while the supply lasts. A publication distributed by the U. S. Department of Agriculture tells you how to hunt and skin Gambian crocodiles.

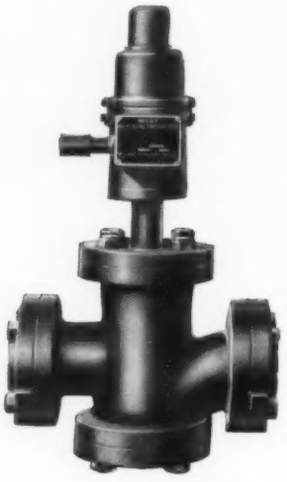
△ Proceedings at the recent United Steel Workers' convention at Atlantic City certainly gave the lie to articles in Fortune, Reader's Digest, etc., which reported how David J. McDonald was losing control of the union.

And just to prove how democratic the union is, proceedings were begun to oust the rebels who dared to have ideas of their own.

△ Latest spaceman gag: "Take me to Brigitte Bardot. I'll see your leader later."

HONEYWELL INSTRUMENTATION FOR
FUEL-AIR RATIO CONTROL SYSTEMS

***ELECTRONIK* FLOW METER** can combine flow recording, indicating, electronic integration, pneumatic or electric transmission and control.



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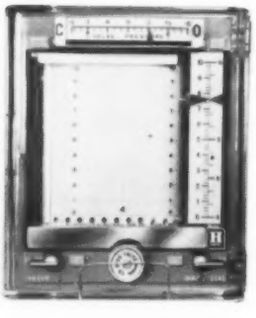

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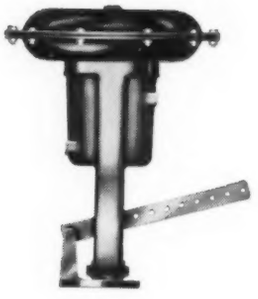

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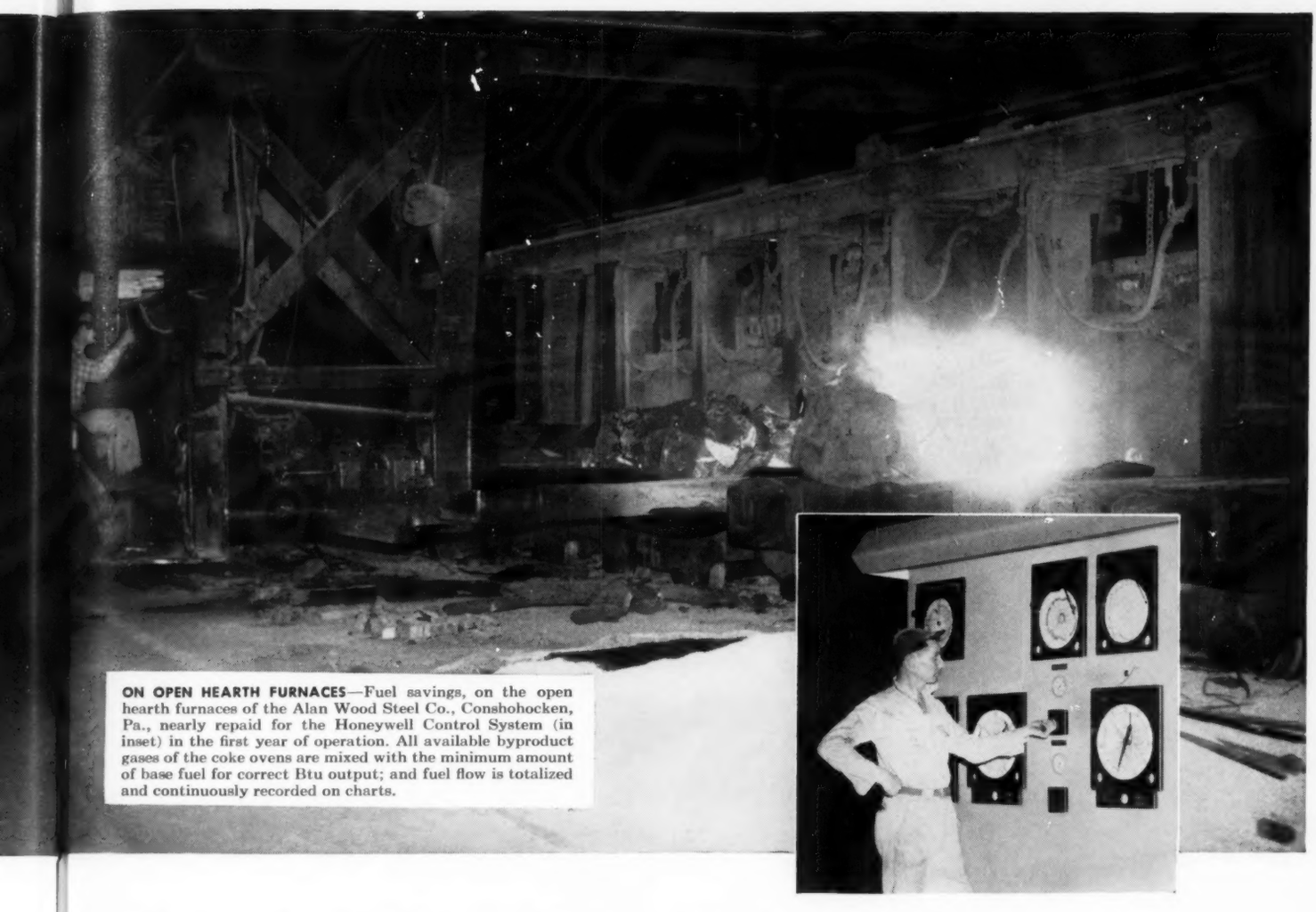

ON OPEN HEARTH FURNACES—Fuel savings, on the open hearth furnaces of the Alan Wood Steel Co., Conshohocken, Pa., nearly repaid for the Honeywell Control System (in inset) in the first year of operation. All available byproduct gases of the coke ovens are mixed with the minimum amount of base fuel for correct Btu output; and fuel flow is totalized and continuously recorded on charts.

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Instrumentation can give you more heat per fuel dollar by increasing heat efficiency . . . by making practical the use of byproduct fuels . . . and by permitting a switch in base fuel whenever outside prices and supply conditions make such a shift profitable.

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First in Control

Q: Where would you look for *Air Products* in this picture?

A: Almost anywhere, in a steel mill.

(Aside from providing the best supply systems for oxygen and other gases, Air Products contributes to steelmaking technology as well.)

Air Products Applications Engineers may be found anywhere in a steel mill. They're hard to pick out because they look like—and are—steel men themselves.

- You may find them in the blast furnace area. *Air Products* oxygen has been used to enrich blast furnaces for over seven years.
- And you'll find them on the open hearth floor, helping to get more tons per hour from furnaces, through startling new practices. They started working with combustion oxygen in 1945 and with roof jets in their earliest stages of development. Current advances in this area at mills served by *Air Products* are helping to raise industry standards on almost a monthly basis.
- If it's an oxygen converter shop, odds are better than even that you'll find *Air Products* there. Many of their innovations have contributed to the growth of converter progress.

Although *Air Products* has changed oxygen from a costly specialty to a basic utility, the story doesn't end there. *Air Products* "steel men" are on the job around the clock . . . to help you increase production and make better iron and steel at less cost.

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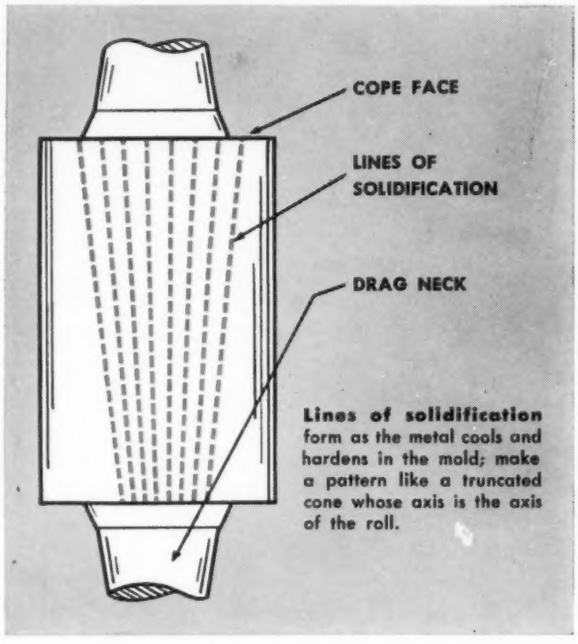
TIPS FROM A ROLL MAKER'S NOTEBOOK

MACKINTOSH-HEMPHILL DIVISION, E. W. BLISS COMPANY, Pittsburgh 3, Pennsylvania

Cast mill rolls • Johnston cinder pots • rotary tube straighteners • end-thrust bearings • heavy-duty lathes • steel and special alloy castings

What we learn from "fingerprinting" a back-up roll


COPE FACE
LINES OF SOLIDIFICATION
DRAG NECK
Lines of solidification form as the metal cools and hardens in the mold; make a pattern like a truncated cone whose axis is the axis of the roll.

"Cope face spot depth" sounds a little mysterious, but actually it is a relatively simple, accurate guide to the future performance of back-up rolls in 4-high mills. Even more important, when the roll maker keeps sulfur print records of the spot depth on every back-up roll he ships, it is possible to relate the pattern of the print to the actual tonnage turned out by the roll, as reported by the customer. With this information at hand, Mack-Hemp metallurgists can modify the alloy "mix" or the foundry practice so that the next set of back-up rolls will give even better service.

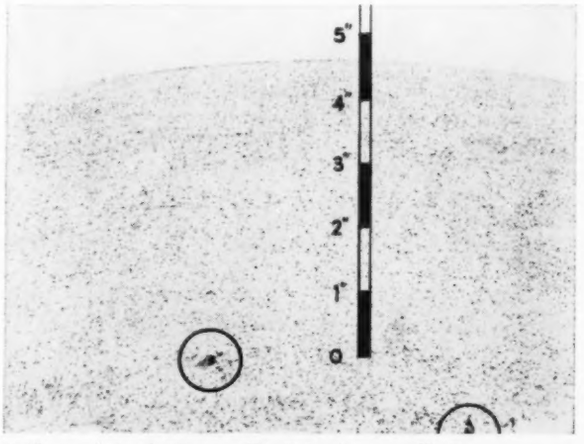
What "cope face spot depth" reveals—As a freshly-poured Mack-Hemp "Technalloy" or "Midland Superalloy" steel back-up roll cools and hardens, so-called "lines of solidification" form below the surface of the roll (see diagram). These lines arrange themselves in a cone-shaped pattern spreading outward as they ascend from the "drag" wabbler toward the upper shoulder of the roll body, or "cope face." The points where the lines of solidification end in the cope face can be detected by an acid etch, and a permanent record made by laying special photographic paper over the etched area.

As you can see, the depth of this zone of dense metal is shallowest at the cope face because of the way the lines angle outward. Hence, cope face spot depth provides a measure of the minimum amount of sound, homogeneous metal between these lines of solidification and the work surface of the roll.

Spots should be deep—In general, the roll maker's objective is to keep the spots on the cope face as deep as possible below the worn-out circumference of the roll. However, sheer depth is not the only indication of the roll's life expectancy and behavior in service. The arrangement and density of the spots also tell their story to the trained metallurgist, particularly when he studies them in the light of performance data from the customer and foundry practice at Mack-Hemp.

* * *

You can see why it's a good idea to keep careful records of tonnages rolled by your Mack-Hemp hot and cold mill back-up rolls. It's a good idea, too, to consult Mack-Hemp on any and all your problems of roll use and selection whenever they arise. Feel free to call or write us at any time.



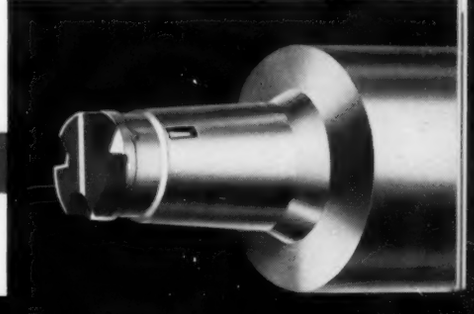
Sulfur print of "Superalloy" back-up roll. Two spots are clearly evident at the bottom of the print (⅓ actual size).

MACKINTOSH-HEMPHILL

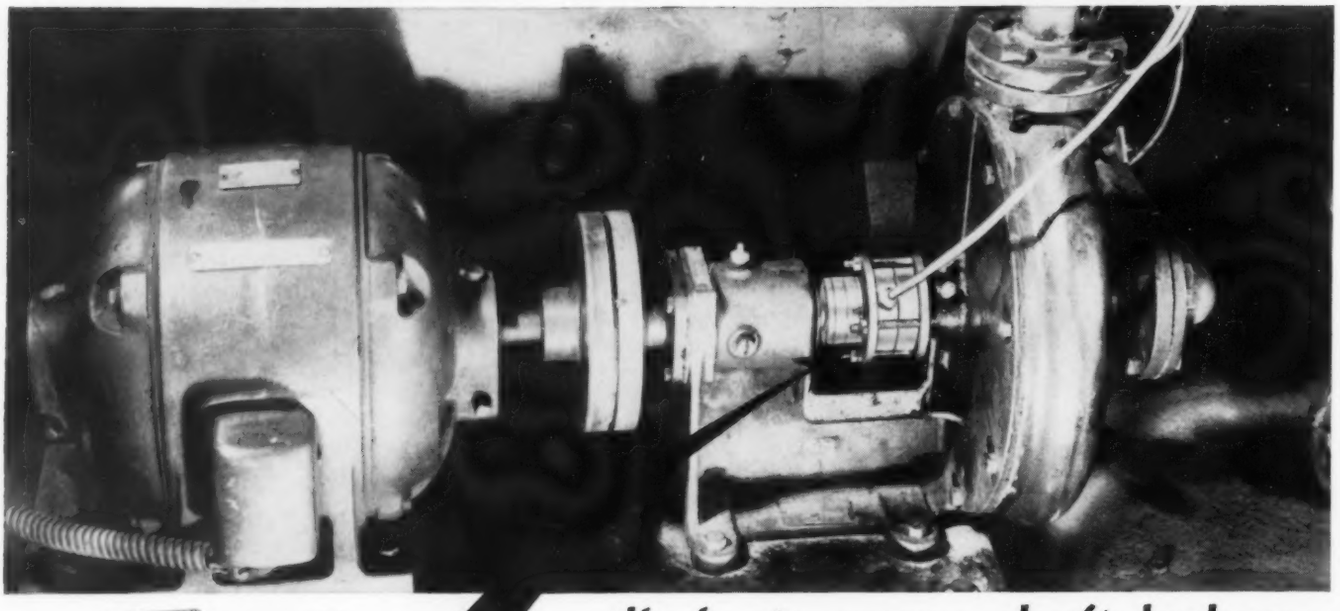
You get more tonnage from the rolls with the Striped Red Wabblers

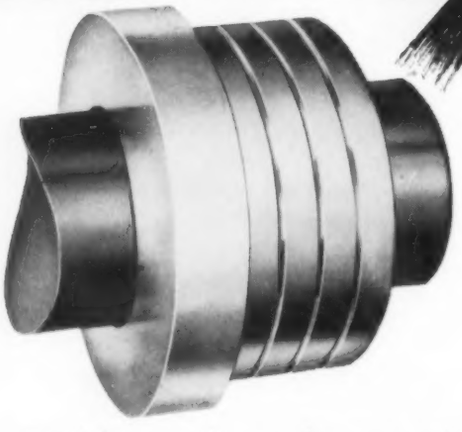
Division of E. W. BLISS COMPANY

Presses, Rolling Mills, Special Machinery



SYNTRON Mechanical SHAFT SEALS





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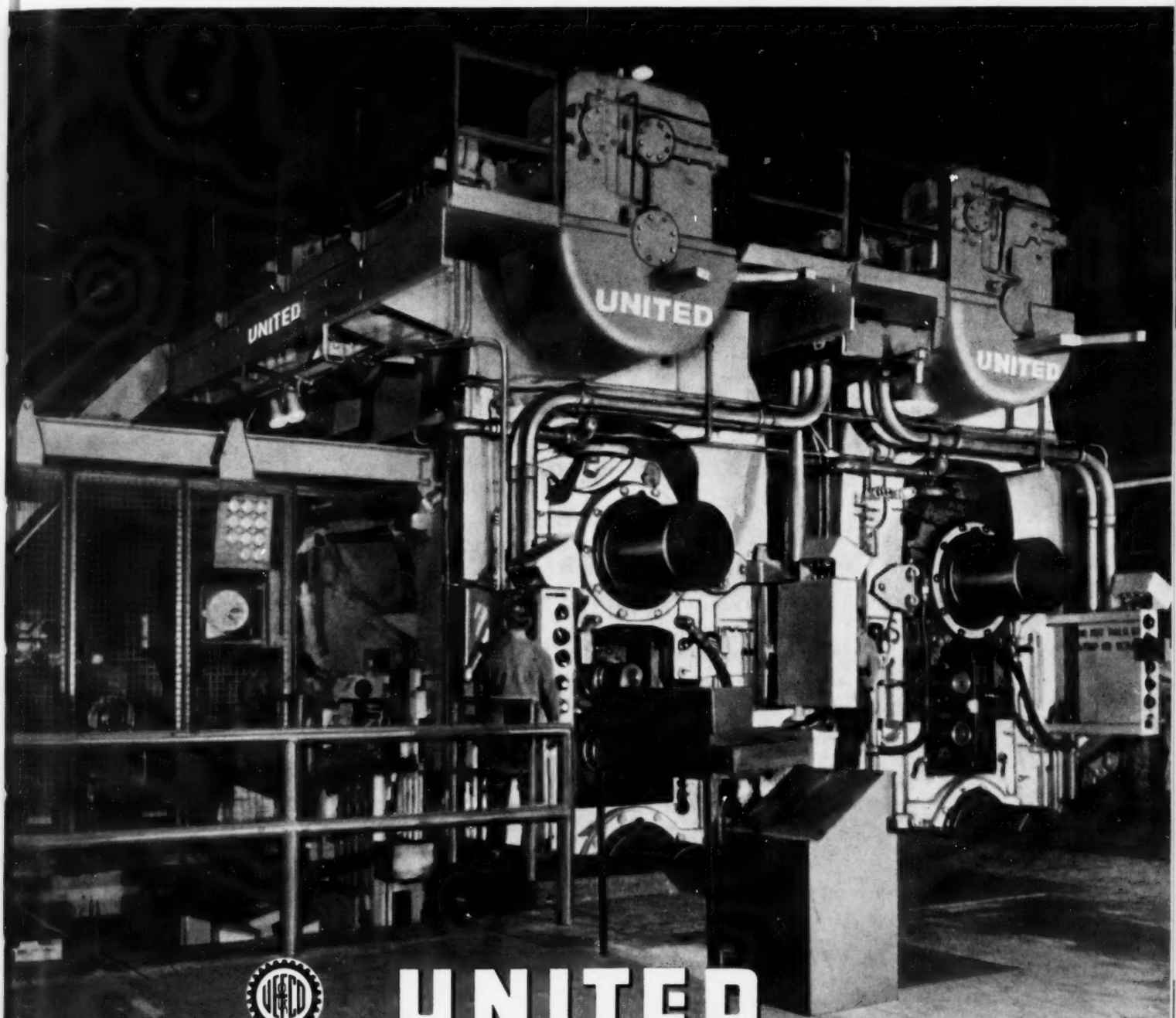

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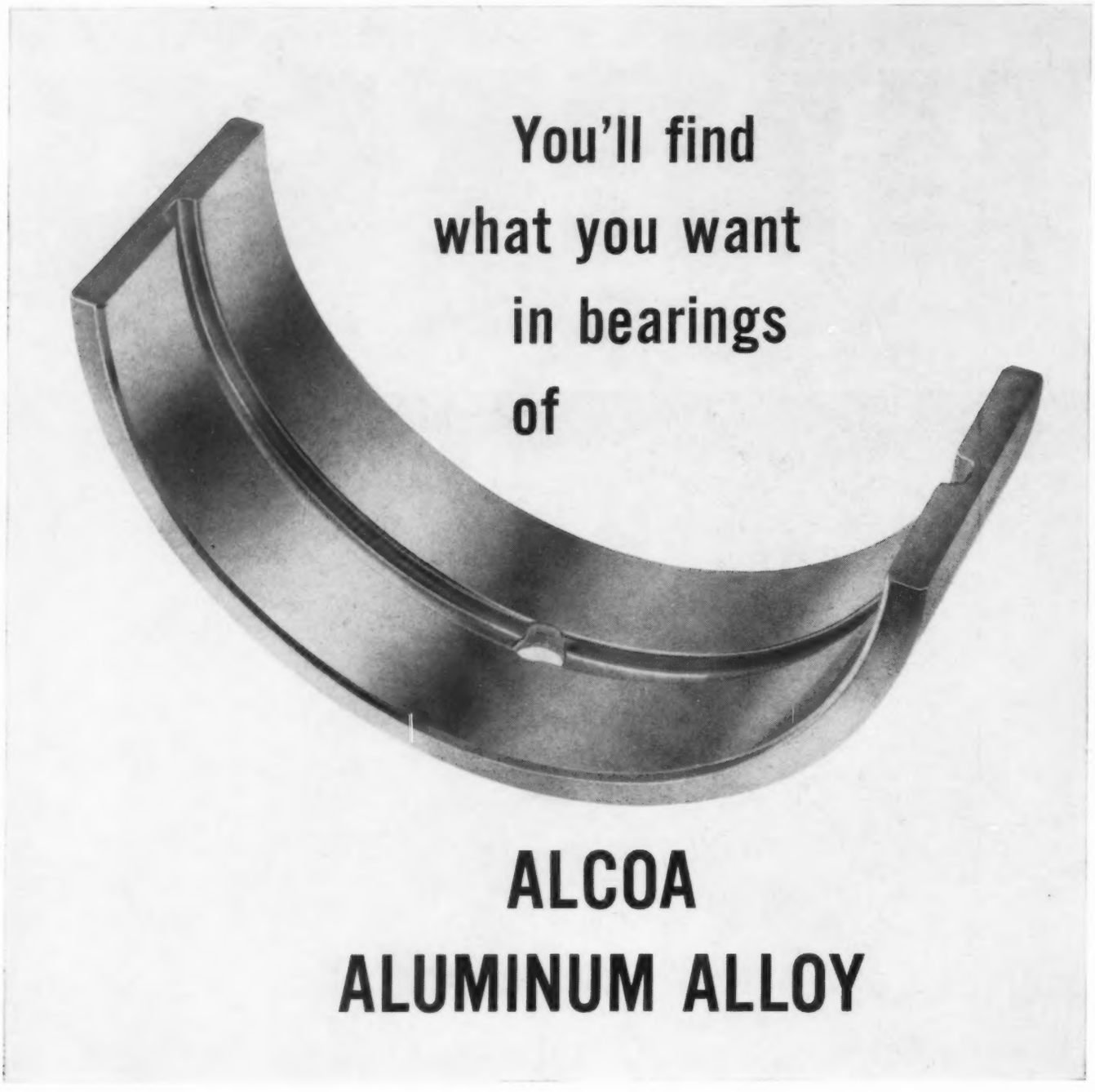

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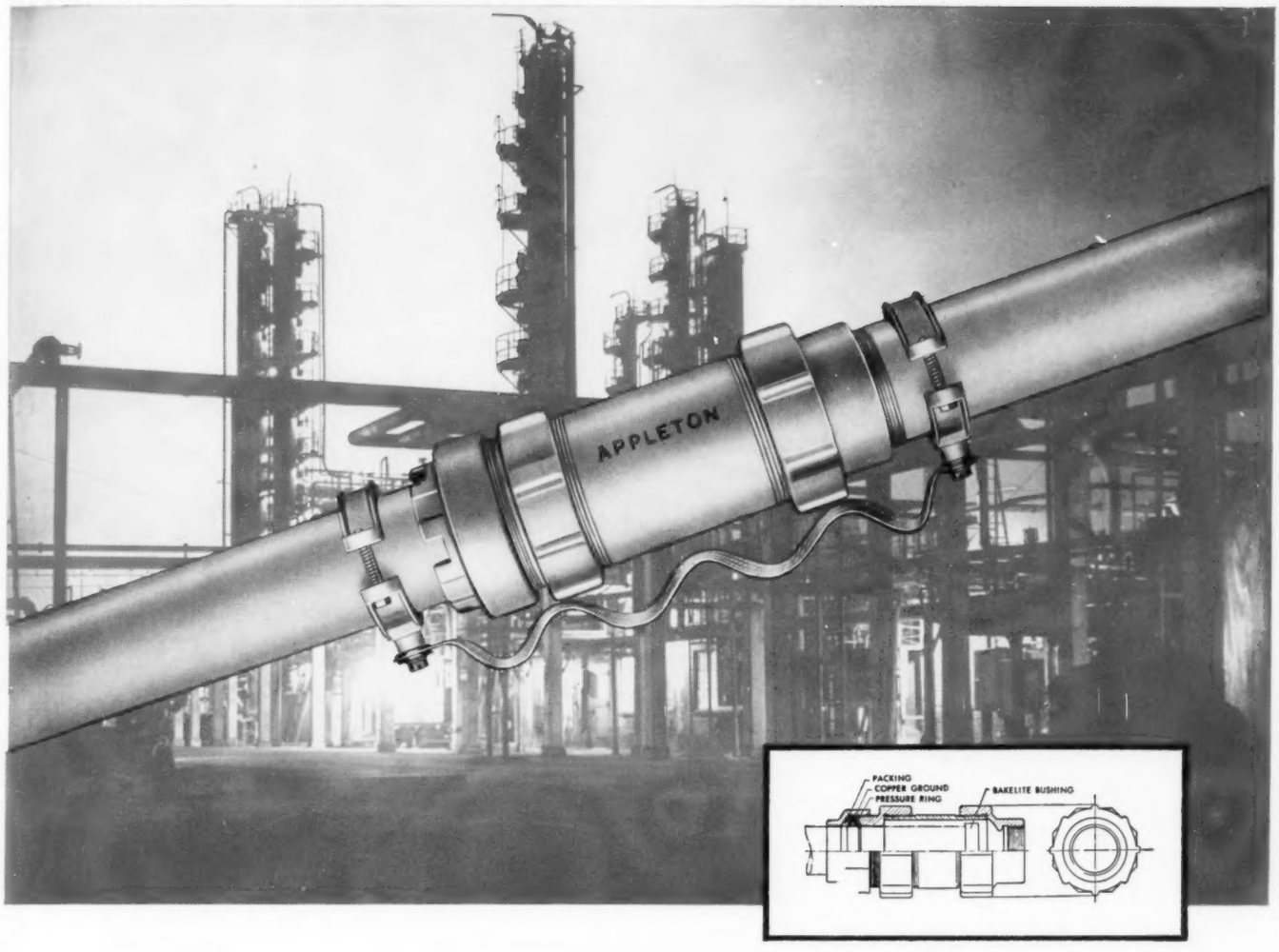
APPLETON® "XJ" Conduit Expansion Joints



Relieve the *strain* of expansion and contraction on long runs of rigid conduit

Temperature changes place a terrific strain on all long conduit runs. To relieve this potentially dangerous condition, it is best to install APPLETON "XJ" Expansion Joints at frequent intervals along the entire system. These weatherproof joints, for use with heavy-wall conduit, have a metallic packing and a bonding jumper to assure the entire conduit system remains a continuous electrical conductor. The jumper, installed in accordance with U. L. recommendations, gives double protection against extreme expansion movement reducing the effectiveness of the metallic bond.

As the conduit is inserted in the joint, a bushing is placed on the end in the manner shown. This bushing permits maximum conduit movement and yet the conduit can never pull free of the joint. The APPLETON "XJ" Conduit Expansion Joint features a metallic packing and pressure ring at the flexible end to keep the joint weatherproof at all times.

Wherever a long run conduit installation exists, the need for APPLETON "XJ" Expansion Joints exists. Interior or exterior, from Texas to Maine, temperature strains do exist, so take advantage of APPLETON'S product research program to give you the precision products you require . . . APPLETON "XJ" Weatherproof Expansion Joints for all long run conduit installations.

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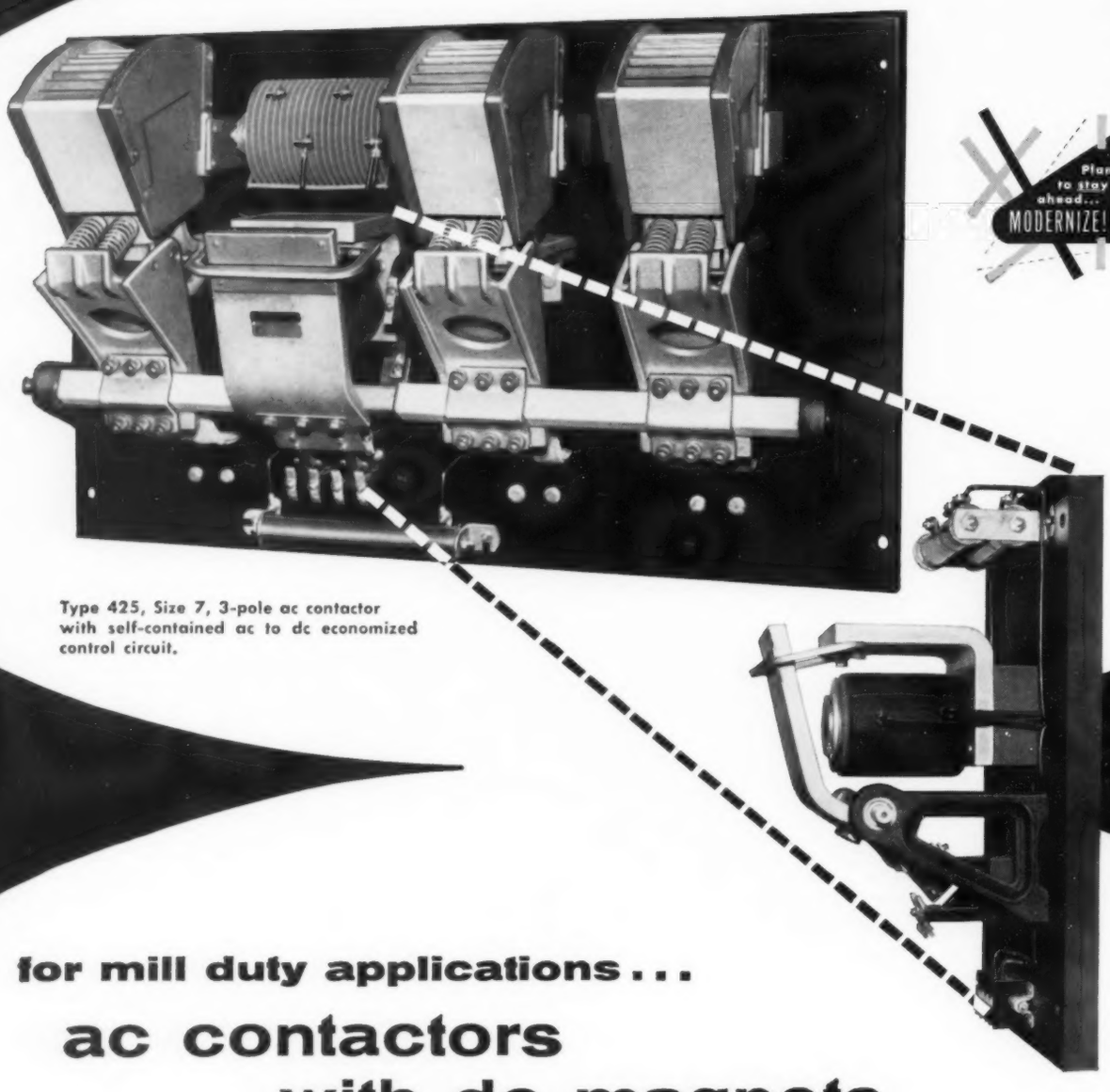

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A-C ALLIS-CHALMERS

A-5793

patent reviews

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period May 6, 1958 through May 27, 1958.

INGOT MOLD

△ U. S. 2,829,410, issued April 8, 1958 to Howard O. Beaver, Jr., assigned to The Carpenter Steel Co., prescribes dimensions for ingot molds, which permit relative freedom from segregation.

A vertical cross-sectional view of the mold is shown in Figure 1. The ratio of the height of the cavity to

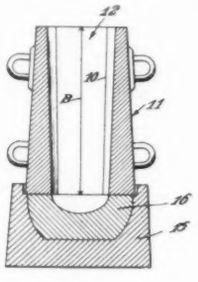

Figure 1

the width of the top-end of the cavity should not exceed 2.6 nor be less than 2. The ratio of the top-end area of the mold wall to the cavity area at the top end should range from 0.50 to 0.70, while at the bottom the value of the corresponding ratio should be between 2.40 and 2.70. To facilitate subsequent working of the ingot, the mold-cavity taper from top to bottom should be minimized. Mold-cavity taper should be between 0.6 in. per ft and 1.0 in. per ft.

INGOT MOLD HOT TOP

△ U. S. 2,835,943, issued May 27, 1958 to Robert E. Daley, relates to the bottom rings for hot tops and to the manner in which they are attached to the hot top casings.

As shown in Figures 2 and 3, the hot top metal casing 1 has an inwardly projecting ledge 2 at its lower end which supports the refractory lining 3. Projecting up into this casing is the central upper part of a bottom ring 4 that also extends outward beneath the metal casing. The ring fits against the bottom of the casing and the downwardly flaring surface of the ledge, and the adjoining upwardly extending surfaces of the ring and ledge are provided with means for detachably connecting the ring to the casing. These include detents or bosses projecting from one of the members and spring clips carried by the other member for gripping the bosses, e.g., the bosses 6 are integral with the metal casing and project inward from it at a number of points around its circumference. The spring clips 7 are metal strips of spring metal, one end of each of which is embedded in the bottom ring. The exposed portion of the strip extends upward and is curved to hook over the adjoining boss. To permit the clip to bend away from the boss when the ring is attached to the casing or removed from it, a pocket 8 is formed in the ring behind each clip. It will be seen that it is a very simple matter to connect the ring to the hot top casing by merely pressing the two together so that the spring clips will snap over the bosses.

The refractory ring projects laterally beyond the outside of the metal casing 1 far enough to overlap the top of the ingot mold 12, with which the hot top is to be used. In other words, the ring originally is too large to be inserted in the mold. Insertion is accomplished, nevertheless, by pressing the ring

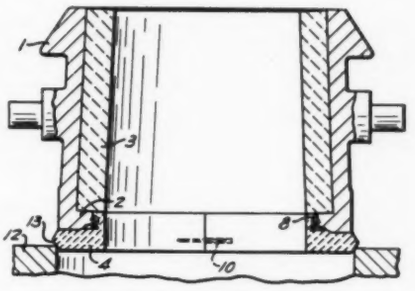

Figure 2

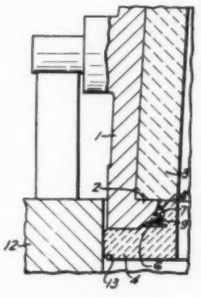

Figure 3

down against the surrounding inner edge of the mold in order to displace the overlapping area of the ring and allow the ring to slide down into the mold in engagement with its inner surface. This displacement is caused by the breaking or shearing off of the excess material in the outermost area of the ring, as indicated in Figure 3. To restrict such breaking to the peripheral area, the area of the ring beyond its line of engagement with the mold edge should have less thickness than the rest of the ring so that it will be weaker. This can be accomplished by providing the portion of the ring that projects beyond the hot top casing with a downwardly and inwardly inclined surface 13. Preferably, the projecting portion of the ring is tapered radially outward so that its upper

surface also is inclined. Consequently, when the ring is pressed down into the mold by the receipt of the hot top, the portion that is broken off will be triangular in cross section and much thinner vertically than the remaining portion of the ring. The rest of the ring will slide down into the mold in fairly snug engagement with the inner surface of the mold, so metal will not be able to rise up between the ring and the mold. After the metal has solidified, the hot top casing can be raised, but the ring will remain attached to the ingot. Bosses 6 will pull away from spring clips 7.

SMELTING OF IRON ORE

△ U. S. 2,833,643, issued May 6, 1958 to Louis L. Newman, relates to the construction and operation of blast furnaces especially adapted for receiving a predominant portion of the heat and reducing agents required for the smelting of the iron ore, in the form of products of combustion discharging from combustion chambers surrounding the bosh portion of the blast furnace.

As shown in Figure 4, a blast furnace 10 of conventional design is provided with stack and bosh portions 12 and 14; upper and lower bells 16 and 18 through which the charge is intermittently fed into the top part of the blast furnace; a hearth 20 which serves as a large basin to collect the reduced metal and slag; a bustle pipe 22 which encircles and equally distributes the heated blast air from the hot blast line, not shown, to each tuyere connection 24; offtakes 26 for the removal of the gases generated in the process; a cinder notch 28 for tapping off the liquid slag; and an iron notch 30 through which the iron is tapped. The furnace diameter increases from the top toward the bottom of the stack to permit the charge to move downward without hindrance. The bosh decreases in diameter from top to bottom and acts as a partial support for the material above it. This decrease in diameter also accommodates the decrease in volume which takes place in the charge as it is melted.

A major portion of the heat and reducing agents required in the smelting process is supplied by products of combustion from a cyclone

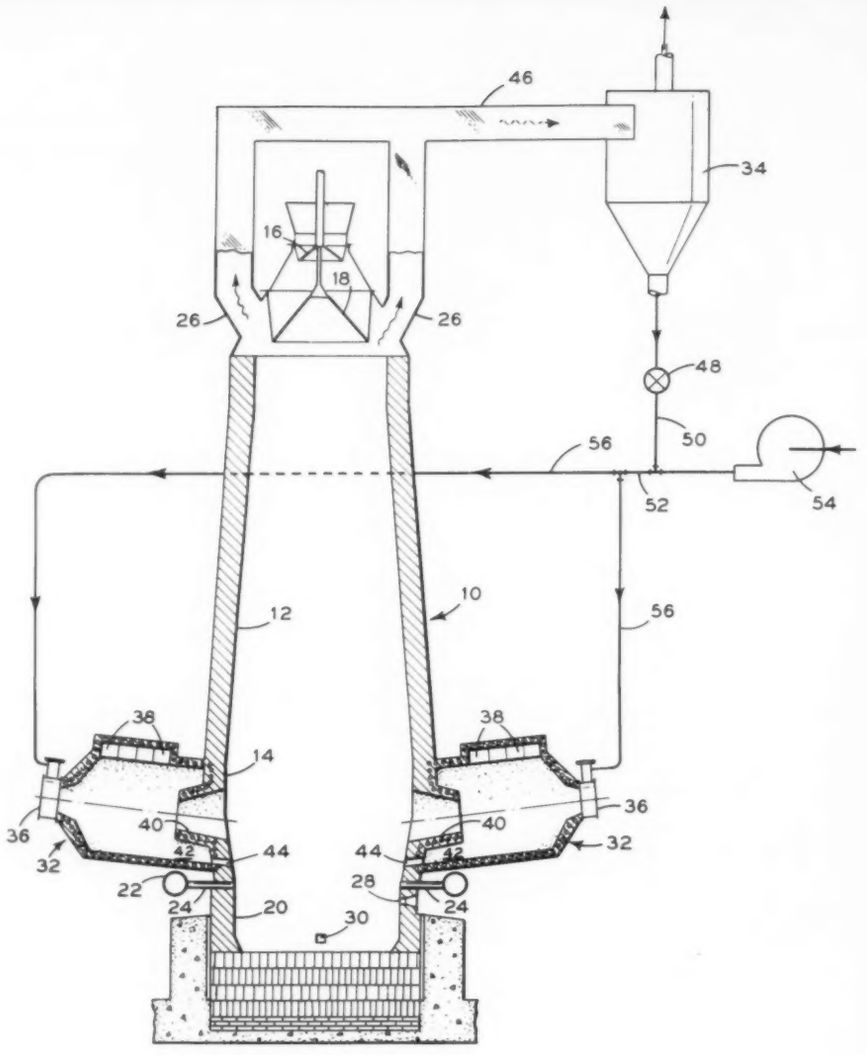

Figure 4

furnace or furnaces 32 arranged circumferentially about and adapted to discharge radially into the blast furnace. The cyclone furnaces are preferably located at a point above the tuyeres 24 where the carbon dioxide is substantially reduced to carbon monoxide. In a thousand-ton-per-day blast furnace, this position is approximately 20 ft above the bottom of the blast furnace. The temperature at this position is about 2820 F. The cyclone furnaces 32 are mounted in the circumferential wall of the blast furnace at a common elevation at a location adjacent the junction of the stack and bosh portions and are arranged symmetrically about the vertical axis of the blast furnace. Each of the cyclone furnaces is of circular cross-section with its major axis arranged substantially horizontal, the furnace chamber being formed by closely spaced studded and fluid cooled tubes covered by a layer of suitable refractory material, and proportioned under normal conditions of operation to maintain a furnace temperature above the fuel ash fusion temperature.

The fuel supplied to the cyclone furnaces may be crushed or coarsely pulverized anthracite, bituminous and semi-bituminous coals, lignite, other solid fuels of like character, gaseous fuels, or liquid fuels such as oil or tar. The fuel may also be a crushed or coarsely pulverized coke, preferably of a quality inferior to the coke customarily used in the blast-furnace charge so as to realize the fuel saving contemplated by the invention.

The flue dust from the dust collectors can be admitted with the fuel to the cyclone furnaces without being subjected to a sintering operation.

It is estimated that 10 to 20 per cent of the normal annual fuel cost for a blast furnace might be saved.

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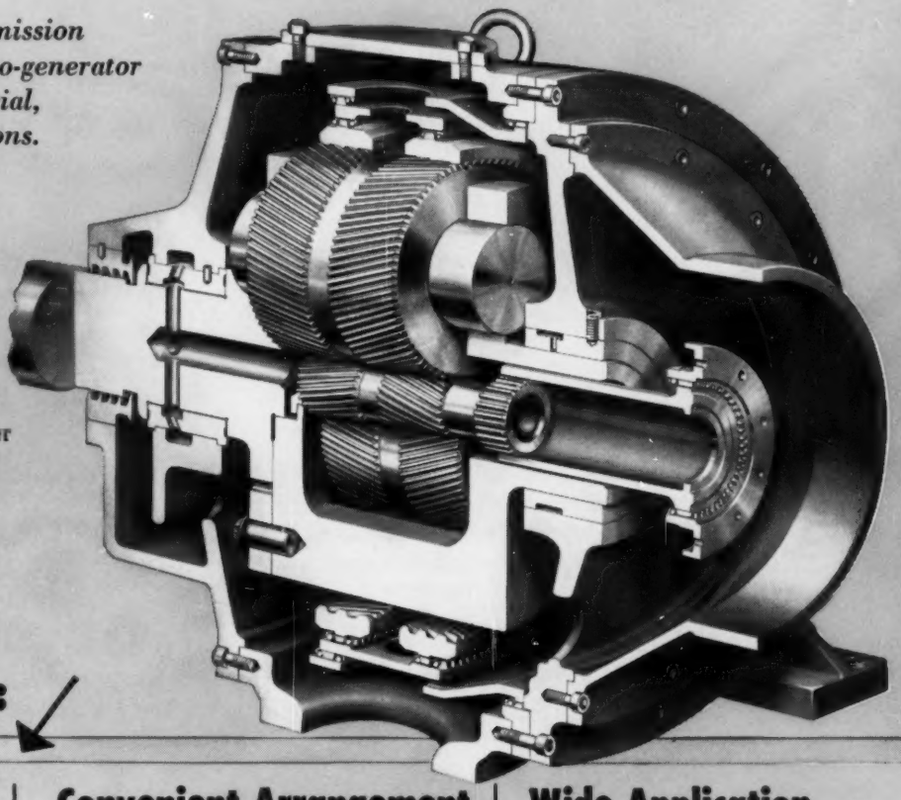
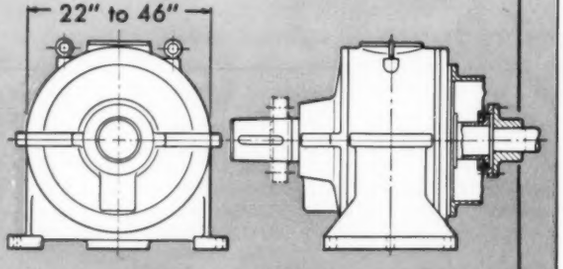
This cutaway view of the De Laval-Stoeckicht Planetary Gear shows how it provides flexibility for proper load distribution throughout the gear members. The thoroughly proved and tested design is completely reliable in transmitting high horsepower for high speed applications. • Highest efficiencies (98% or higher)... no high speed bearings... less friction losses.



Check These Advantages:

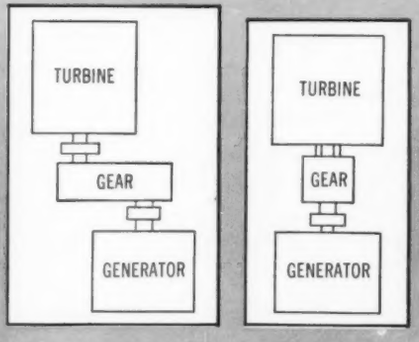
Small Size—Light Weight

Compact—low weight per hp. Sizes range from 22" to 46" in diameter, depending on horsepower requirements. Example: 5000 hp planetary unit weighs 1700 lbs. against 6000 lbs. for conventional gear.



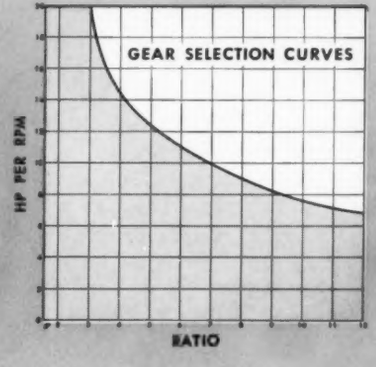
Convenient Arrangement

Co-axial or "in-line" arrangement of gear members takes up far less space than parallel axis gears of equivalent horsepower rating.



Wide Application

Capacity range shown in shaded area on chart below. For other applications, contact your De Laval Sales Engineer.



For further details, write for Bulletin 2400.

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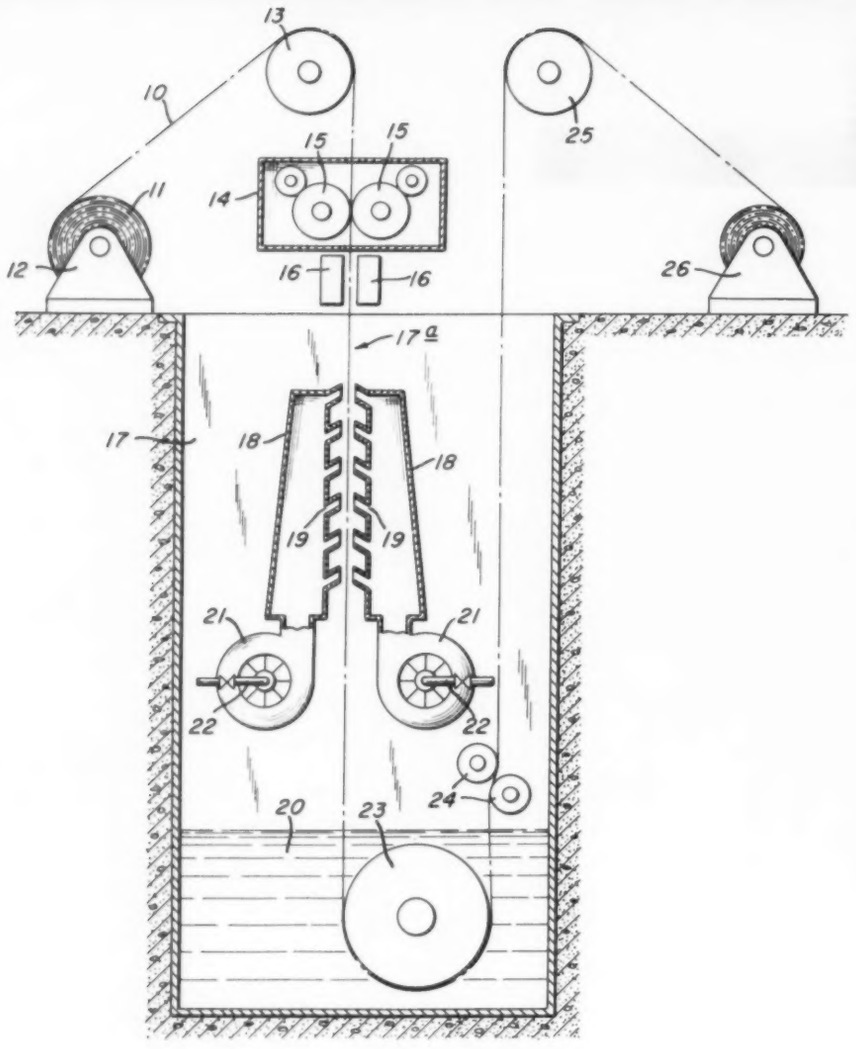


Figure 5

CONTINUOUS APPLICATION OF A PROTECTIVE FILM OF LACQUER TO STEEL STRIP

△ U. S. 2,833,672, issued May 6, 1958 to Aner N. Laubscher and George H. Rendel, assigned to United States Steel Corp., relates to the coating of low-carbon sheet steel with a commercial lacquer, and its curing, in a continuous operation.

It has been found that a film of lacquer can be cured rapidly and without charring, by suddenly raising its temperature along a steeply ascending gradient, to a value much higher than the top of the normal curing range, provided the coated material is cooled substantially immediately with equal rapidity to a temperature below the normal curing range.

As shown in Figure 5, a low carbon steel strip 10 of tin-plate gage, which has been thoroughly cleaned, is unwound from a coil 11 mounted on an uncoiler 12, trained over a guide sheave 13, and drawn downwardly through a coating tank 14. The tank has contact rolls 15 between which the strip passes, and contains a coating material such as the organic lacquer which has been used heretofore for coating can stock, e.g., a synthetic resin dissolved in a suitable solvent.

Immediately after passing through the coating tank, the strip is heated almost instantaneously to a temperature much higher than that conventionally used in curing a lacquer-coated steel sheet, thus flashing the lacquer solvent into vapor. The heating is accomplished by high-frequency induction units 16 which induce eddy currents in the strip. As shown, the strip passes between two of the units spaced slightly apart. They should be of sufficient capacity to hear the strip at rates as high as 500 F per sec, so as to reach a temperature of 500 to 800 F at high speeds of travel, e.g., 600 fpm without requiring units of too great length, i.e., over 8 or 10 ft.

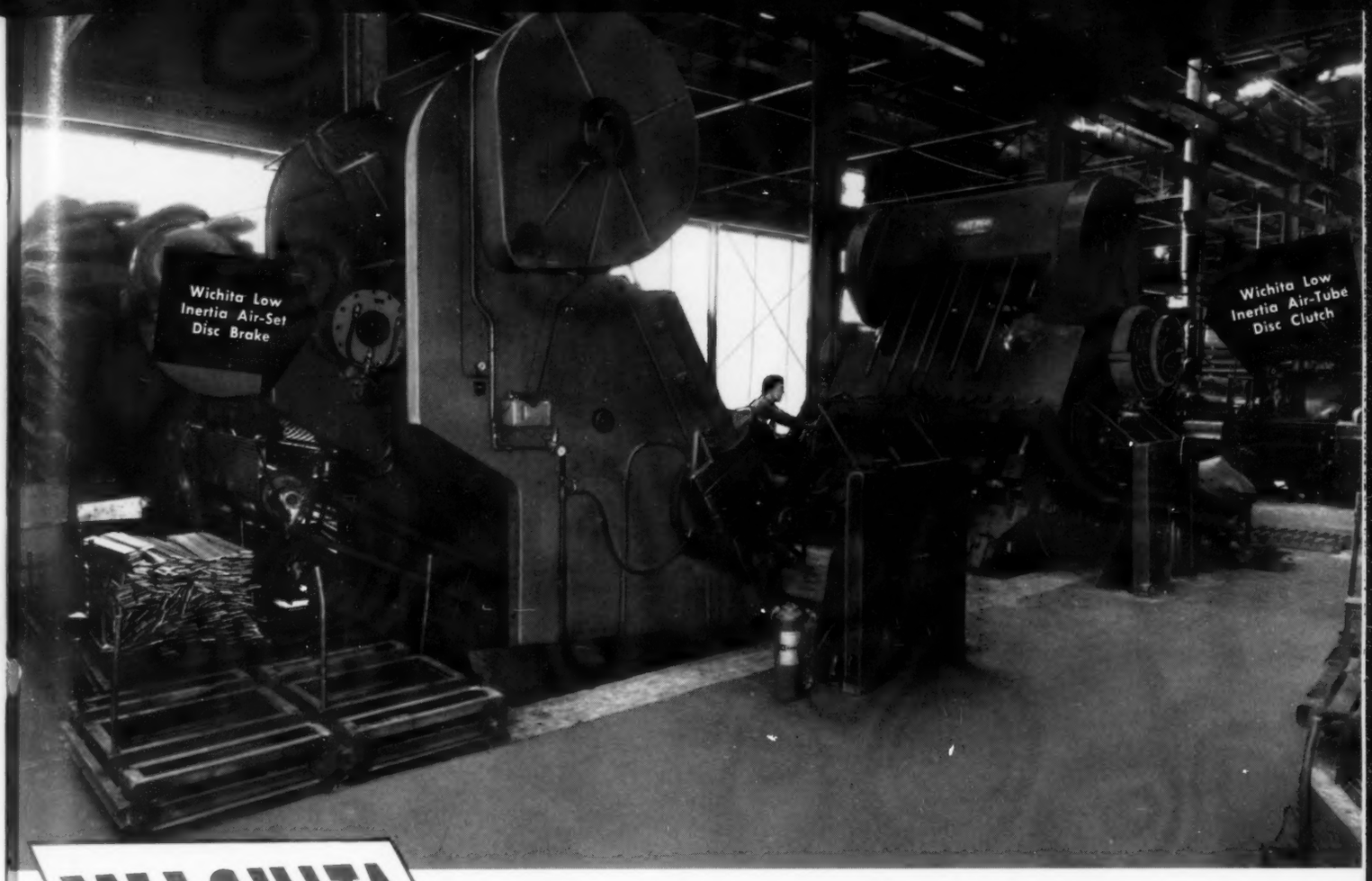
After being heated to the desired temperature by the heating units 16, the strip enters a curing zone 17a at the top of a quenching chamber 17 in which the film becomes fully cured. The strip then passes between spaced cooling manifolds 18 having nozzles 19 for discharging air jets thereon, and then into a final quenching bath 20 of water at the bottom of the chamber. Blowers 21 deliver air to manifolds 18, and sprays or atomizers 22 connected to a water supply may be used to cause entrainment of water droplets in the air streams. The strip travels around a guide sheave 23 immersed in the quenching bath and then passes upwardly between wringer rolls 24 to a guide sheave 25 above the top of chamber 17. The strip dries as it ascends by virtue of its residual heat and is drawn around sheave 25 to a recoiler 26.

SCRAP CAR

△ U. S. 2,836,309, issued May 27, 1958 to Harry L. McFeaters, as-

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or assignee
2,833,008	5/6/58	Hot top for ingot molds	Oglebay Norton Co.
2,833,532	5/6/58	Checker-work construction for regenerators	Lewis B. Ries
2,833,642	5/6/58	Binder additive for making ore pellets	General Mills, Inc.
2,834,266	5/13/58	Transload device	United States Steel Corp.
2,834,267	5/13/58	Grating	United States Steel Corp.
2,834,406	5/13/58	Coke oven	Carl Otto
2,834,593	5/13/58	Pallet for sintering machines	Armco Steel Corp.
2,834,668	5/13/58	Mixture for treating cast iron	Union Carbide Corp.
2,835,485	5/20/58	Grate for sintering machine	National Malleable & Steel Castings Co.
2,835,570	5/20/58	Zinc die casting steels	Allegheny Ludlum Steel Corp.
2,835,571	5/20/58	Steel for use at elevated temperature	United States Steel Corp.
2,835,619	5/20/58	Method of heat treating cast iron	The International Nickel Co.
2,836,486	5/27/58	Exothermic alloy addition agent	Union Carbide Corp.



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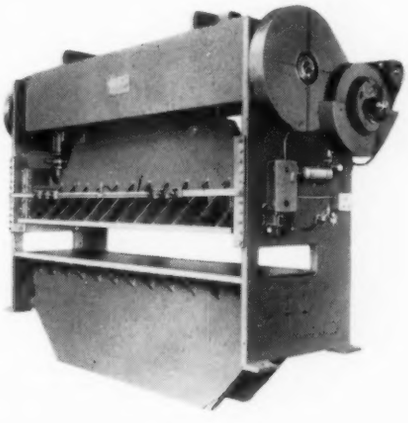

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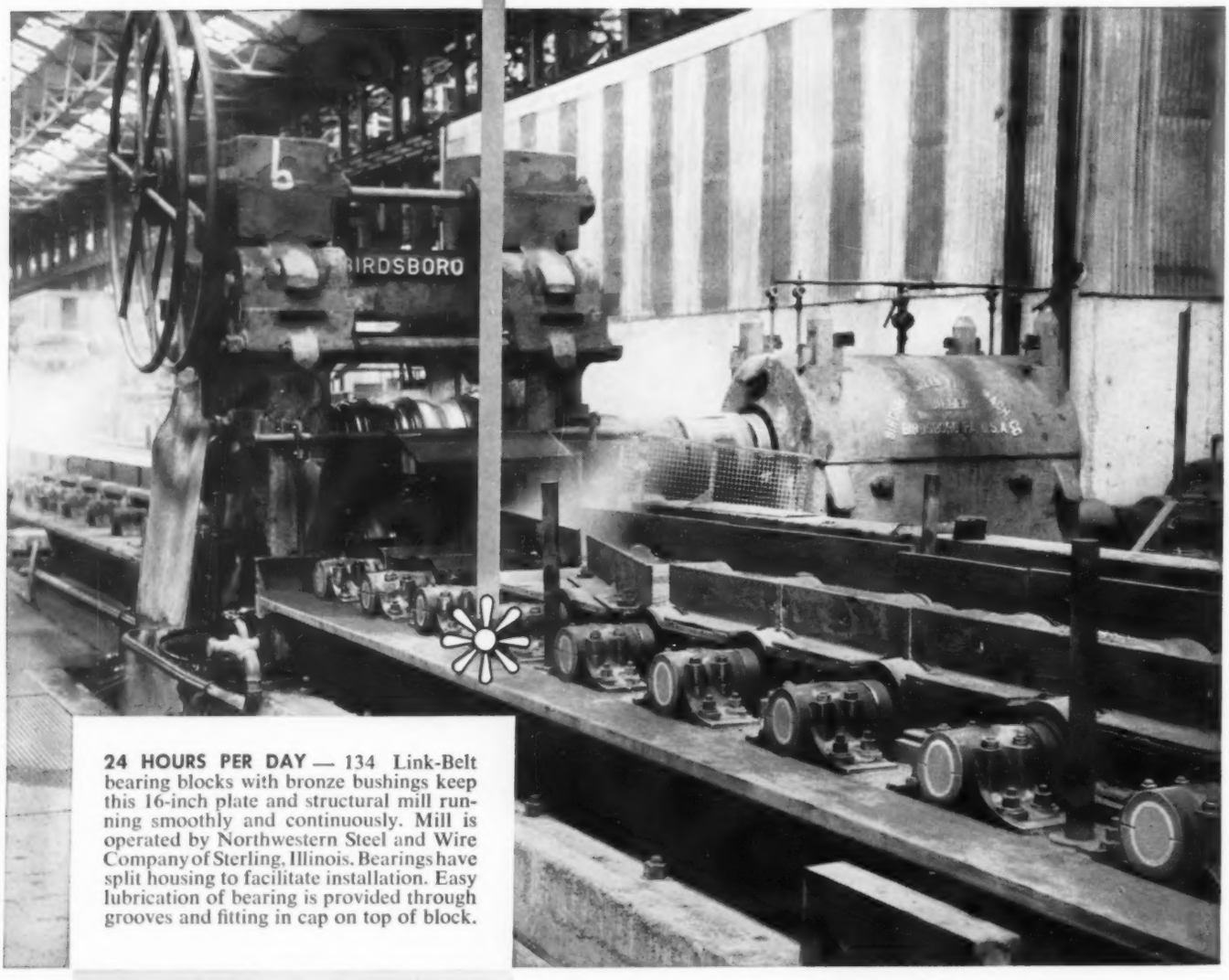

24 HOURS PER DAY — 134 Link-Belt bearing blocks with bronze bushings keep this 16-inch plate and structural mill running smoothly and continuously. Mill is operated by Northwestern Steel and Wire Company of Sterling, Illinois. Bearings have split housing to facilitate installation. Easy lubrication of bearing is provided through grooves and fitting in cap on top of block.

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signed to Pennsylvania Engineering Corp., describes a transport and delivery car for scrap, for use with oxygen-type converters.

The scrap car is movable as a unit between suitable operating positions such as between a source of scrap and the front or discharging end of a refining vessel or furnace 12 (see Figure 6). At the latter position, its upper frame or part 45 is movable to align one of a series of scrap containers, holders or boxes with the charging opening or mouth of the furnace or refining vessel (see Figure 7).

BLOWING NOZZLE FOR REFINING

△ U. S. 2,836,411, issued May 27, 1958 to Josef Auer, assigned to Huttenwerk Oberhausen A.G., describes a lance for refining metals by blowing a blast onto the surface of a metal bath.

It is the object of this invention to provide a liquid-cooled lance which is characterized by a low consumption of cooling water and which without being subject to destruction makes it possible to blow such great quantities of blast per unit time that in the time required for refining, the heat losses of the melt by radiation will be comparatively low.

As shown in Figures 8 and 9, the lance consists primarily of two concentric tubular bodies arranged one within the other. The outer tubular body is designated with the reference numeral 1, whereas the inner tubular body is generally designated with the reference numeral 2. The inner wall surface of the tubular body 1 defines with the

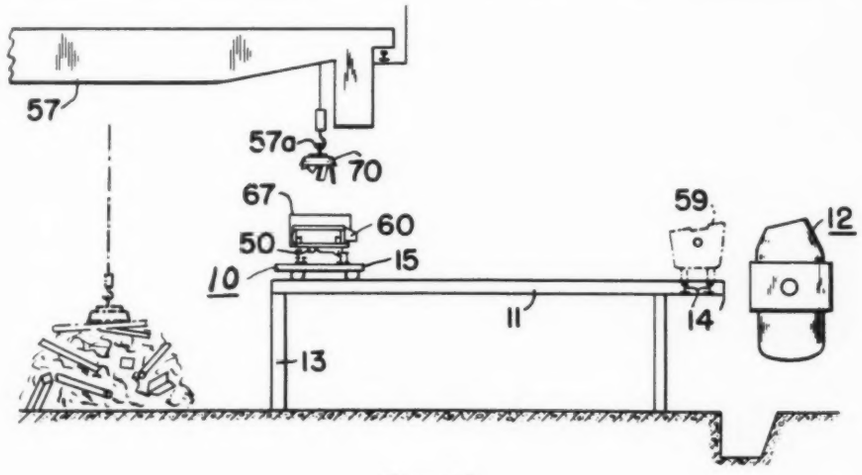
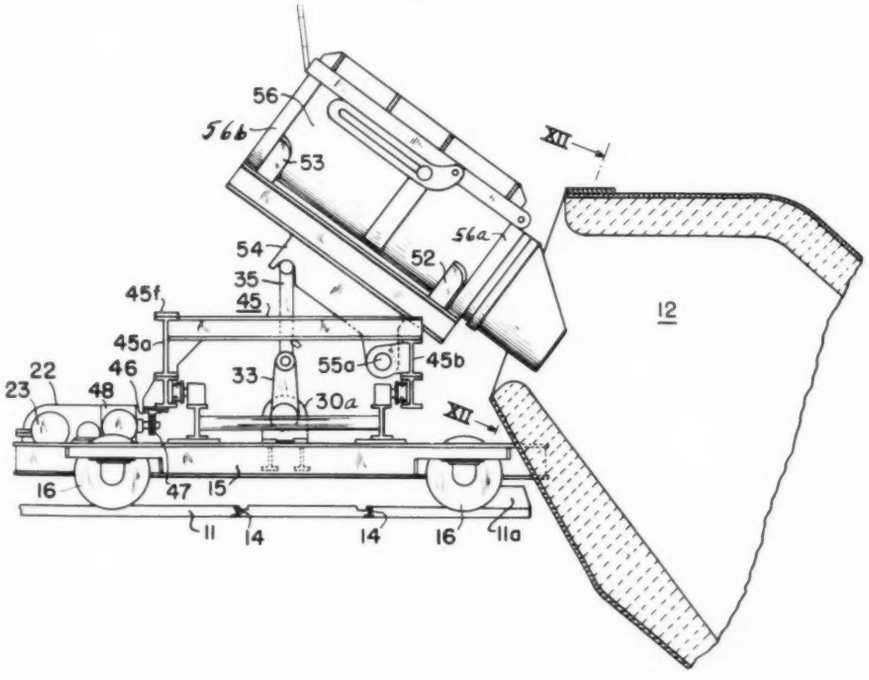


Figure 6

Figure 7



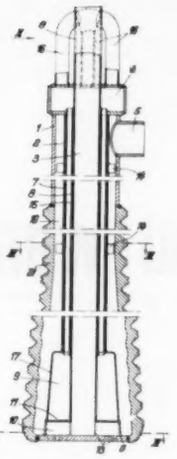


Figure 8

opposite wall surface of the inner tubular body a jacket 19 for cooling water, which conduit is closed at its upper end by means of a tubular header 4. The tubular body 1 is provided with a lateral discharge connection 5 for discharging the cooling water. A plate 6 is inserted into the lower end of the tubular body 1 and forms the bottom wall of the lance.

The inner tubular body 2 consists of two pipes 7 and 8 placed coaxially one within the other in spaced relationship from each other,

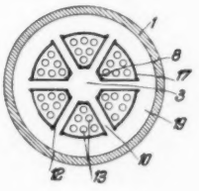


Figure 9

thereby confining with each other a feeding conduit of annular cross section for feeding the blast to the mouth of the lance. The inner wall surface of the tube 8 defines a central chamber of feeding conduit 3 for conveying the cooling agent to the mouth of the lance. Thus, the outer annular chamber or conduit 19 for the return of the cooling agent is separated from the feeding conduit 3 for the cooling agent by the feeding conduit for the blast.

A large reaction surface is provided between the blast emerging from the nozzle and the melt, while the formation of a coherent reaction zone and local overheating of the bath is avoided. Due to the large reaction surface, the heat developed by the refining operation is conveyed to the rest of the bath, whereby the danger of thermal damage to the tuyere is considerably reduced.

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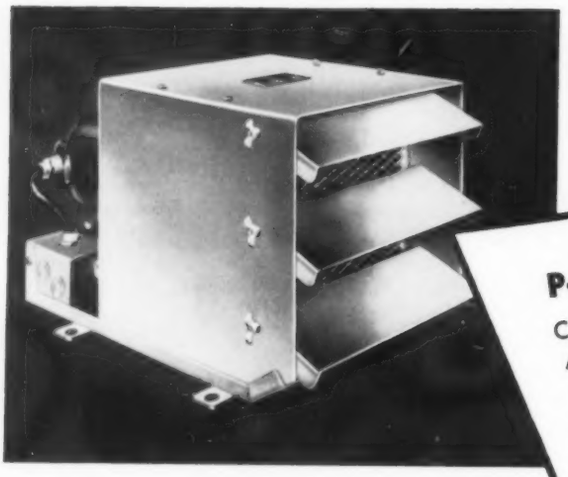

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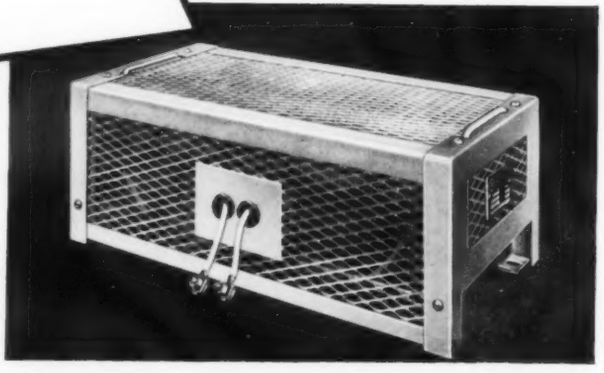

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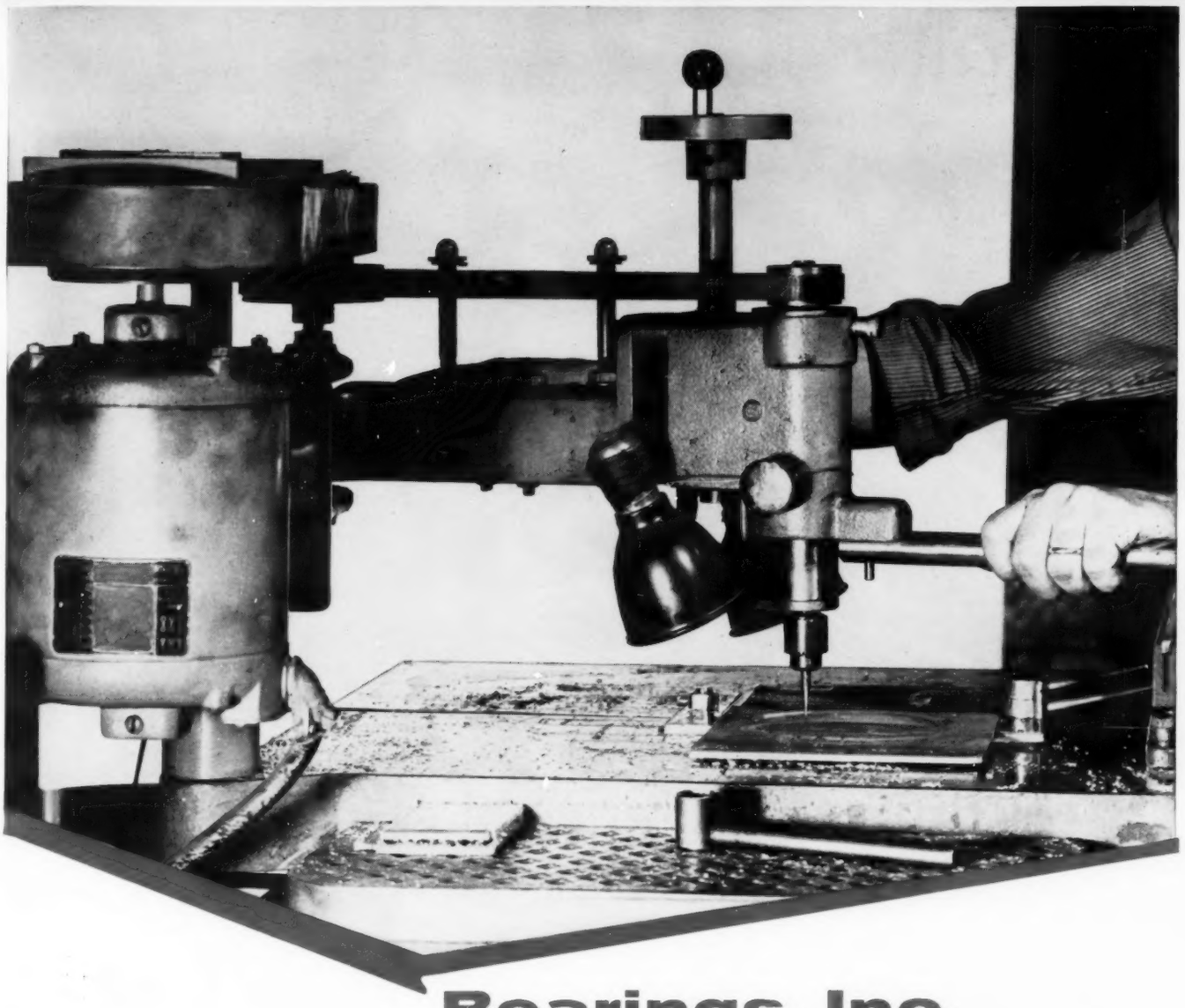

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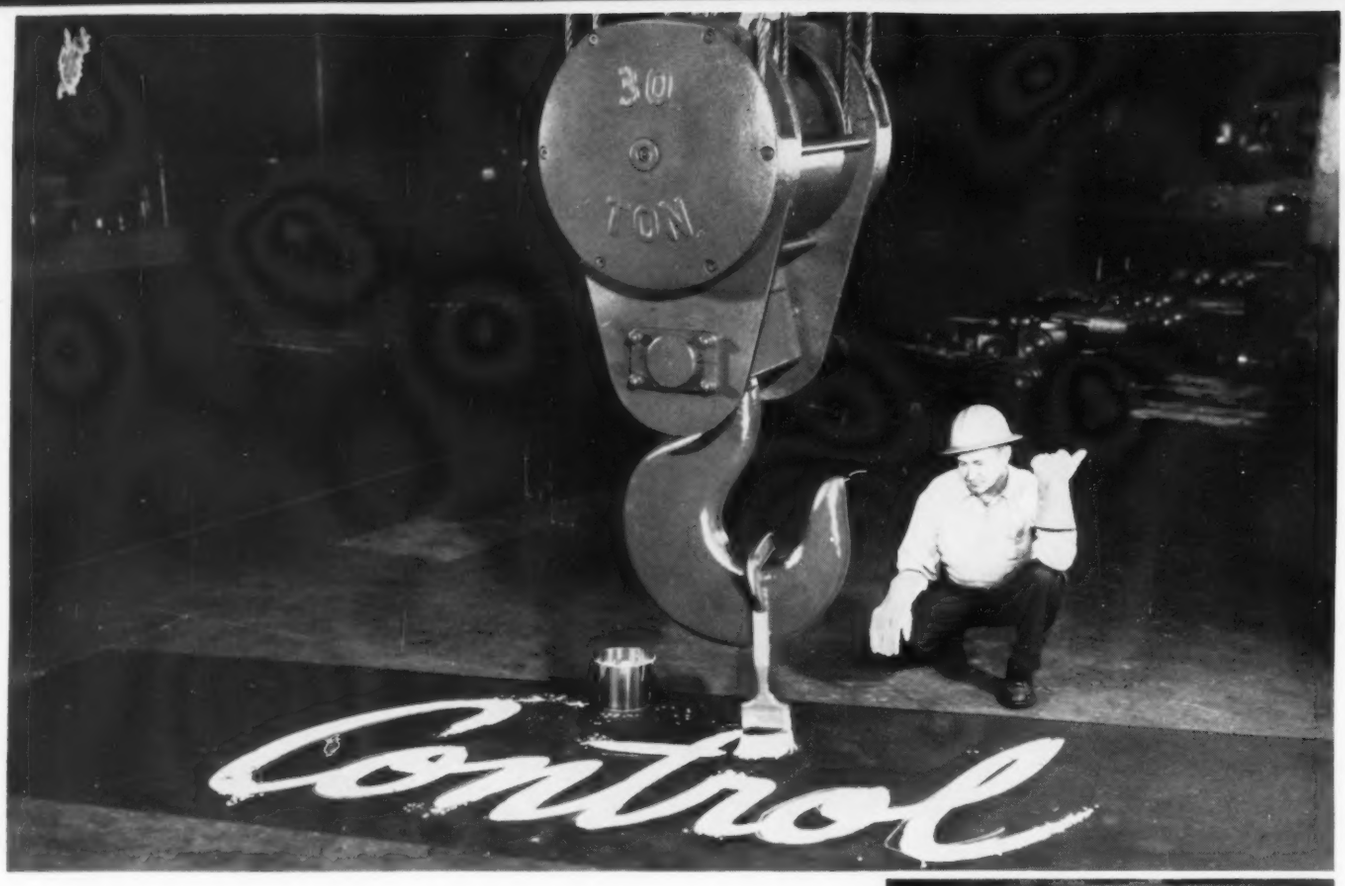

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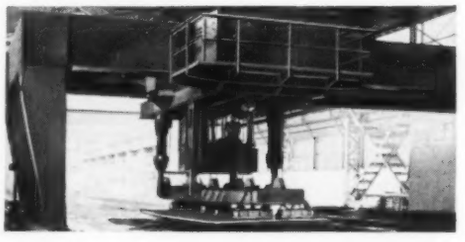

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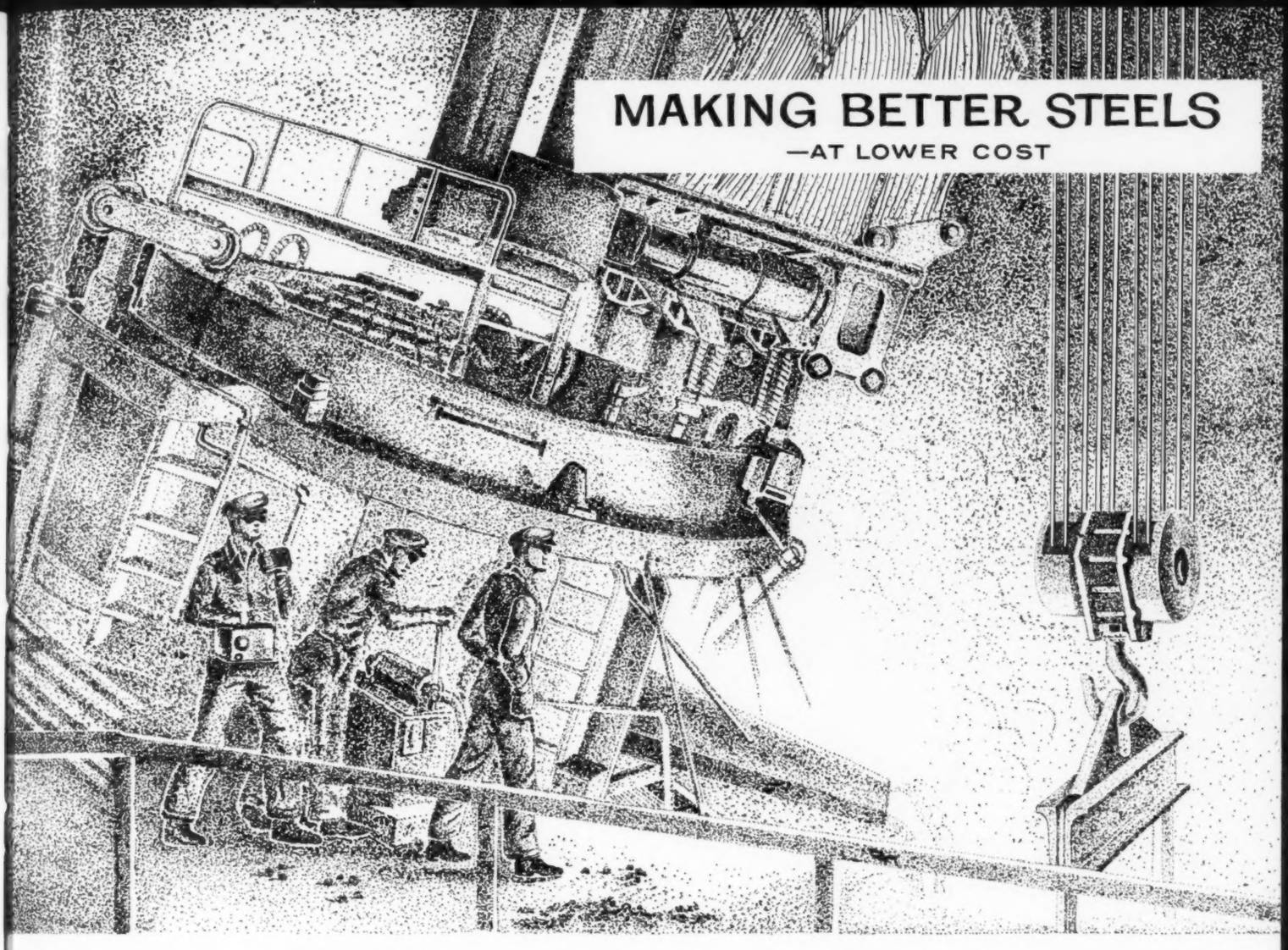

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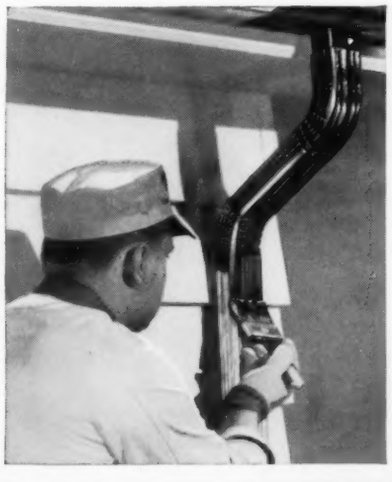

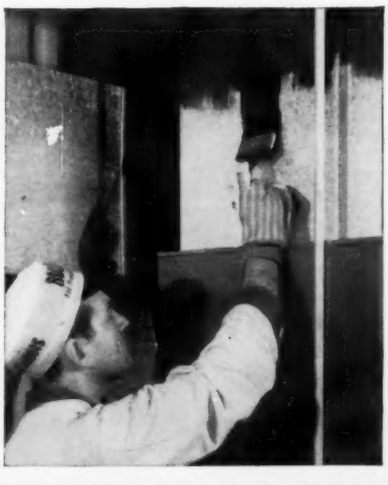

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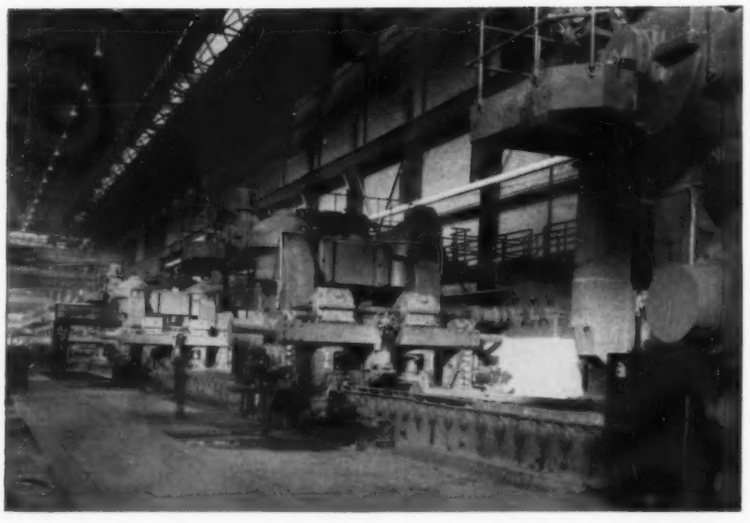
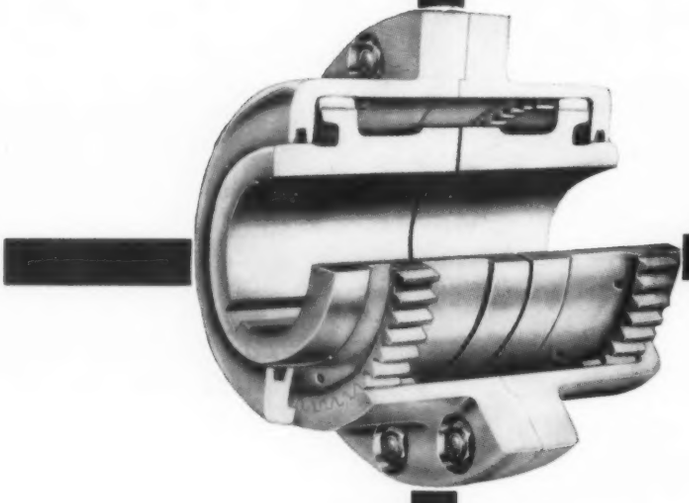
No flexing materials to crystallize or break . . . No welded parts . . . Filled with oil, self-lubricating . . . Oil tight, dust tight . . . Permits free lateral float . . . Stronger than shafts it connects . . . Compensates for both off-set and angular misalignment.



Steel mill drives equipped with POOLE FLEXIBLE COUPLINGS.



Get the whole story from our handbook, "Flexible Couplings." A copy will be sent gladly without obligation.

the better

FLEXIBLE COUPLING

POOLE FOUNDRY & MACHINE COMPANY

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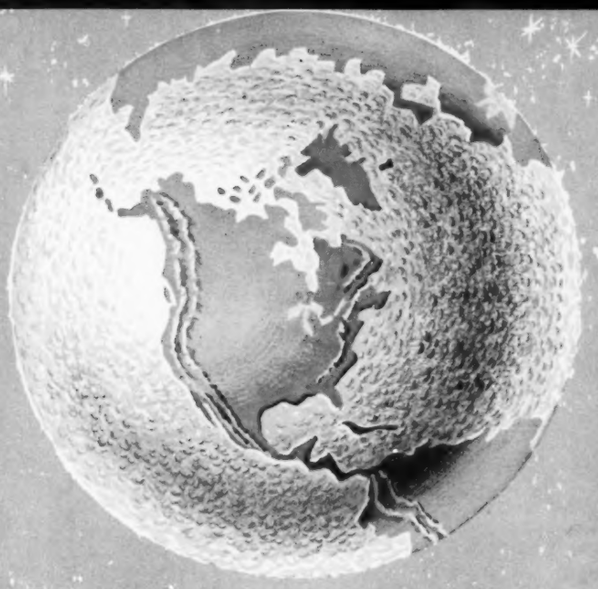
BALTIMORE 11, MD.



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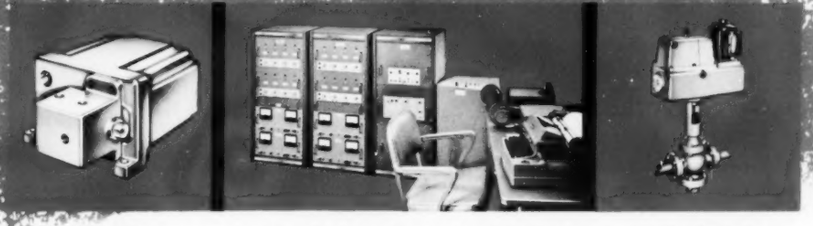

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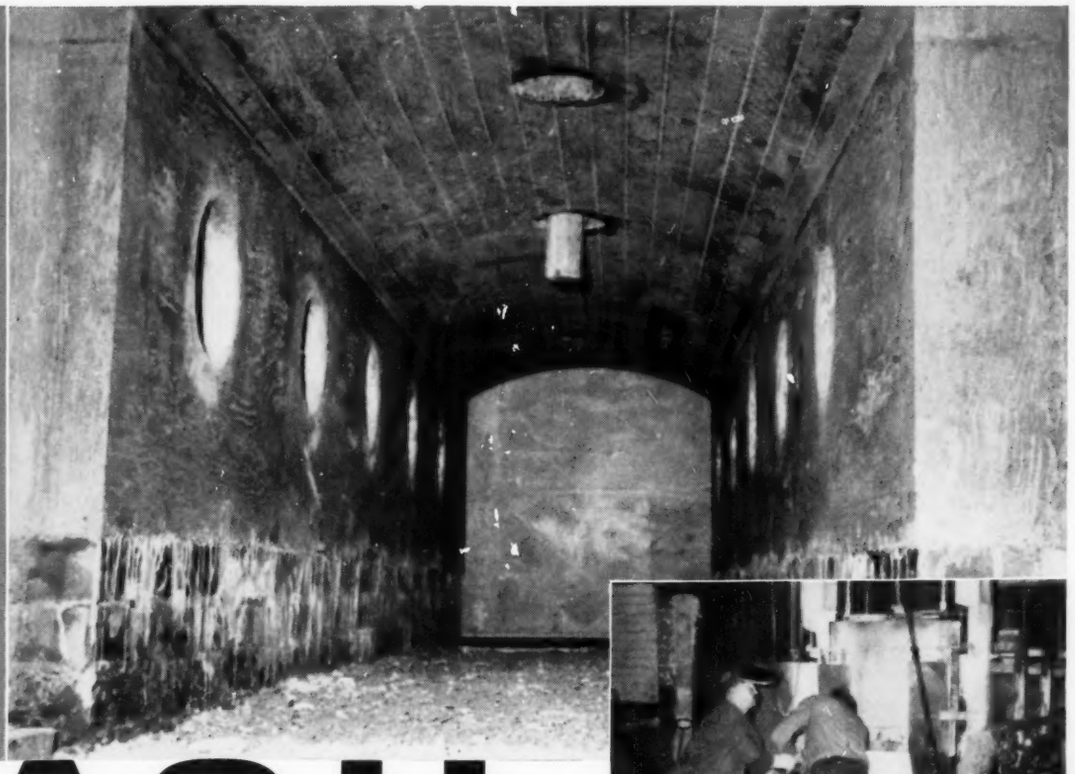
weld-forging furnace arch and sidewalls CAST of . . .



TASIL HYDROCAST

. . . increases lining life— reduces rebuild labor costs!

Top photo: Arch and sidewall construction of weld-forging furnace, cast of TASIL HYDROCAST, before hearth rebuild. Note clean, joint-free appearance of Hydrocast.

Lower photo: This furnace in operation.

A mid-west manufacturer of hardened steel parts operates side-fired, weld-forging furnaces at 2350° F. These were formerly constructed of fireclay brick and shapes with 2000° F. insulating brick backup. Service life of the firebrick was 12-15 months—due to considerable attack on the lining by borax flux used in the welding process.

The arch and sidewalls of these furnaces are now *cast in one piece* with TASIL Hydrocast. Rebuild time was cut from 2 to 3 *days* normally required for the firebrick construction, to 3½ *hours* pouring time for Hydrocast. Furnace life *increased* to 24 months.

Fast, easy replacement, coupled with excellent durability, makes TASIL Hydrocast highly economical as a replacement for firebrick construction in many types of furnaces. Let the Taylor field engineer in your area give you full details.

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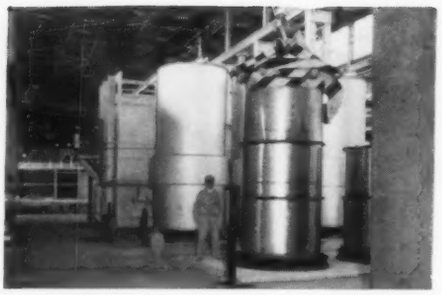

Part of an installation of large gas fired three-stack rectangular bell type forced circulation special atmosphere furnaces for annealing strip.

Bell Type FURNACES

Built to Suit Your Plant, Product or Process

Built right—over 20 years ago—this EF installation is still in operation, daily—and producing first class work.

EF direct gas fired forced circulation bell type furnace for processing wire, rod, strip and other products. The split cover design permits installing where head room is limited.

Single or multi-stack — circular, rectangular or square types — upright, elevator or partial pits — gas fired, oil fired or electric — correctly designed, built and installed, ready to produce.

Backed by over 40 years of practical furnace building experience, EF furnaces incorporate all the advantages of all bell type designs, for processing strip, wire, rod and other ferrous and non-ferrous products.

EF bell type furnaces installed over 20 years ago are still in service daily, producing first class work. After all, there's no substitute for experience. At your convenience EF experienced engineers will be pleased to discuss the best type for your specific requirements.

THE ELECTRIC FURNACE CO.

GAS FIRED, OIL FIRED AND ELECTRIC FURNACES FOR ANY PROCESS, PRODUCT OR PRODUCTION

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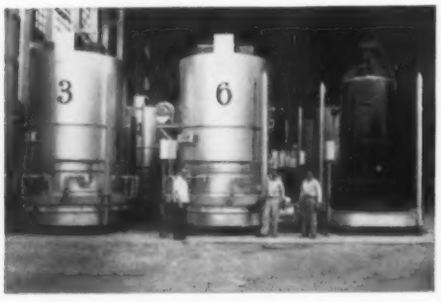
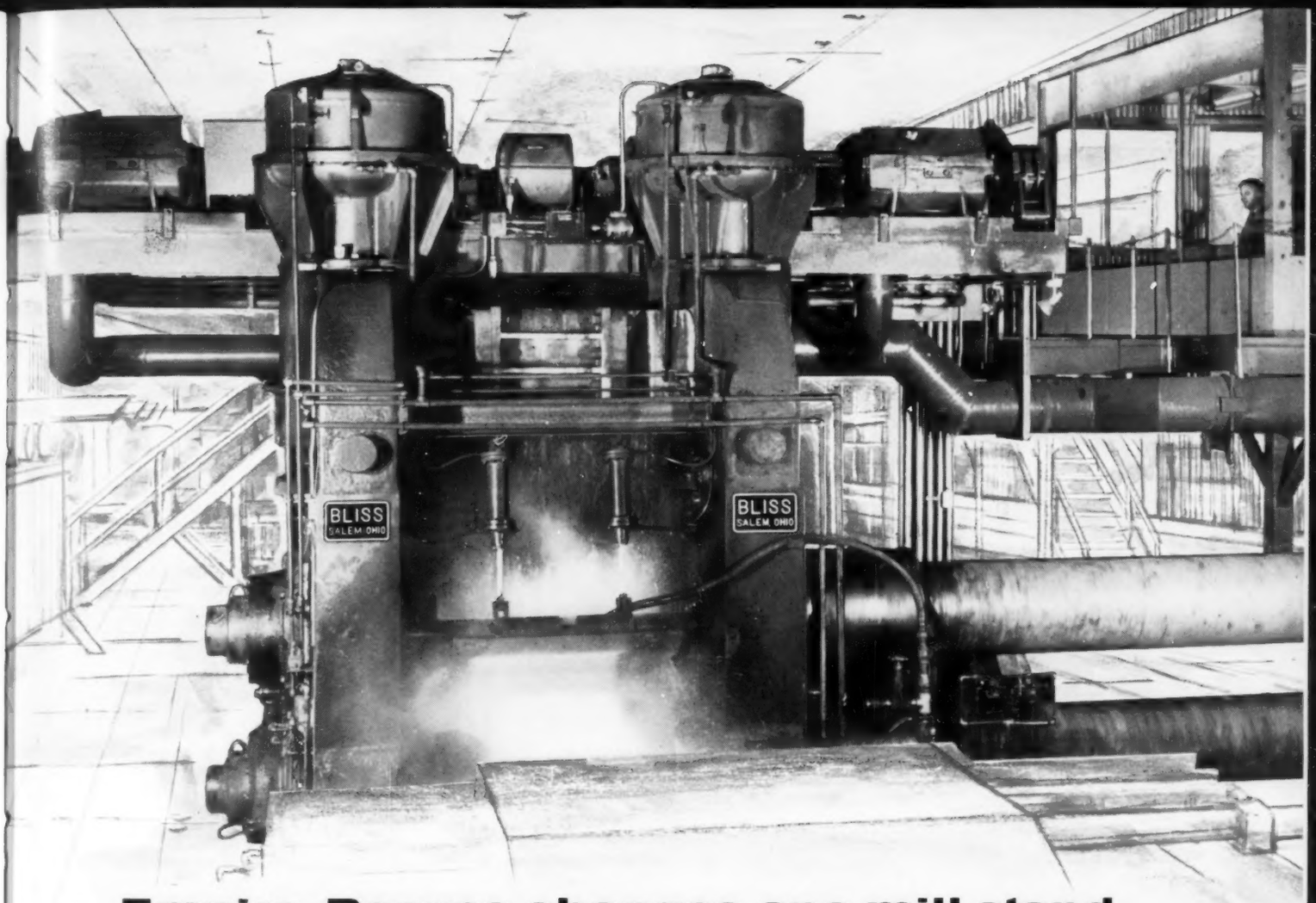


EF direct gas fired special atmosphere forced circulation, single stack circular bell steel strip annealers, each accommodates three 48" x 40" 15,000 lb coils (45,000 lbs.)

Part of another installation of large EF gas fired three-stack rectangular bell type forced circulation special atmosphere furnaces for annealing steel strip.

EF gas fired special atmosphere rectangular bell type strip annealers with individually controlled forced circulation three-stack bases each with capacity of 135,000 lbs. per charge.



Empire-Reeves changes one mill stand, gains 85% boost in hot strip capacity

The famous hot strip line at the Mansfield, Ohio plant of Empire-Reeves Steel Corporation... the first mill in the world to roll fine-gage strip from ingot in a straight line without a reheat... has just had its capacity practically doubled by replacing a three-high one-way intermediate roughing mill with the new Bliss 38" x 52" reversing mill shown here.

Before the addition, the line averaged fifteen 4-to-5-ton ingots per hour. With the new Bliss mill, capacity ranges to 28 to 30 ingots per hour. Five-inch slab coming from the slabbing mill at the head of the line is reduced to ½-inch, where formerly the slabber had to roll the ingot into ¾-inch slab before the single pass through the old intermediate rougher.

Efficiency of the new mill is further enhanced by the use of a control system that automatically resets the mill between passes at the touch of a button.

Besides the new mill, Bliss' Rolling Mill Division built and installed a new shear that crops the strip ends before the strip enters the finishing train, and provided the new expanding-mandrel type downcoiler at the end of the line.

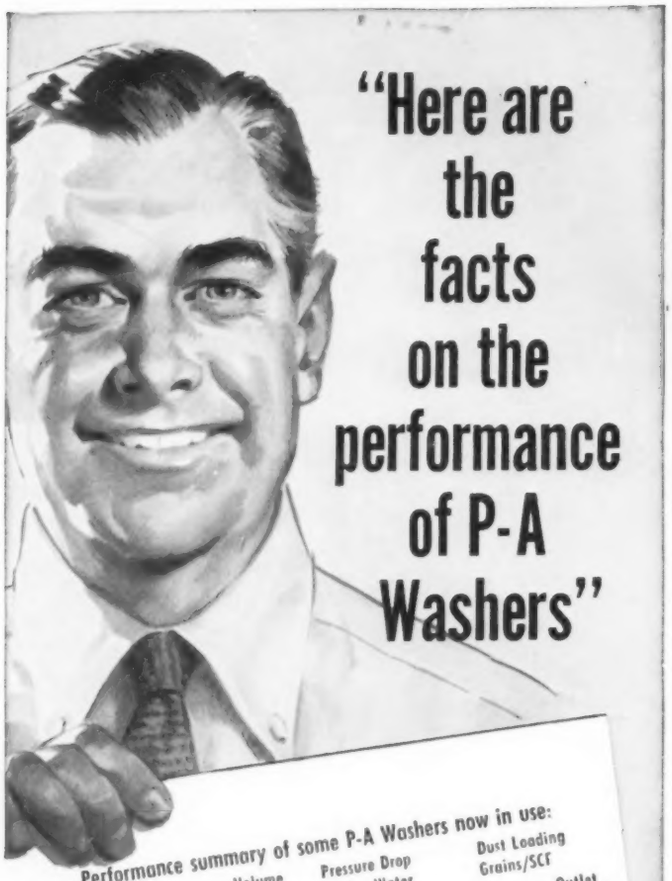
Whether you're interested in a single mill or a complete rolling plant, you'll find that the Bliss Rolling Mill Division will bring a sharp insight to your special rolling problem . . . an insight that can translate mill design and layout into striking new economy and efficiency. For examples of its work, write today for a free copy of the new 84-page Bliss Rolling Mill Brochure, Catalog 40-B.

BLISS
SINCE 1857 ®

Bliss is more than a name . . . it's a guarantee

E.W. BLISS COMPANY, Rolling Mill Division, Salem, Ohio

Subsidiary: The Matteson Equipment Company, Inc., Poland, Ohio



"Here are the facts on the performance of P-A Washers"

Performance summary of some P-A Washers now in use:

Installation	Years Operated	Volume SCFM	Pressure Drop Inches Water	Dust Loading Grains/SCF Inlet	Dust Loading Grains/SCF Outlet
A	4	78,000	30	3-19.0	.01-.04
B	3½	78,000	30	2-3	.02-.08
C	3	85,000	30-40	2-3	.01-.03
D	3	45,000	30	2	.02-.03
E	½	75,000	50	—	.02
F*	½	26,000	12	5	.10
G*	½	26,000	12	5	.10
H	½	90,000	29	—	.04

*Two units in parallel on one furnace. Lower efficiency due to lower available top pressure

These actual performance figures reflect the highly efficient operation of the Pease-Anthony washer. This venturi scrubber puts your full top pressure to work cleaning the gas. No secondary cleaner required for most installations. Present users report no maintenance problems. If you have a blast furnace scheduled for construction or rebuilding, plan now for P-A Venturi installation. Capacities up to 150,000 SCFM. Write for bulletin M-103.

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P-A GAS SCRUBBERS

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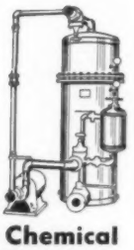
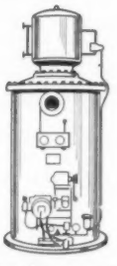
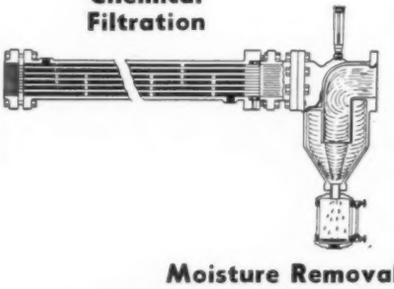


Chemical Filtration



Industrial Water Filtration



Moisture Removal from Compressed Air and Gas Systems –

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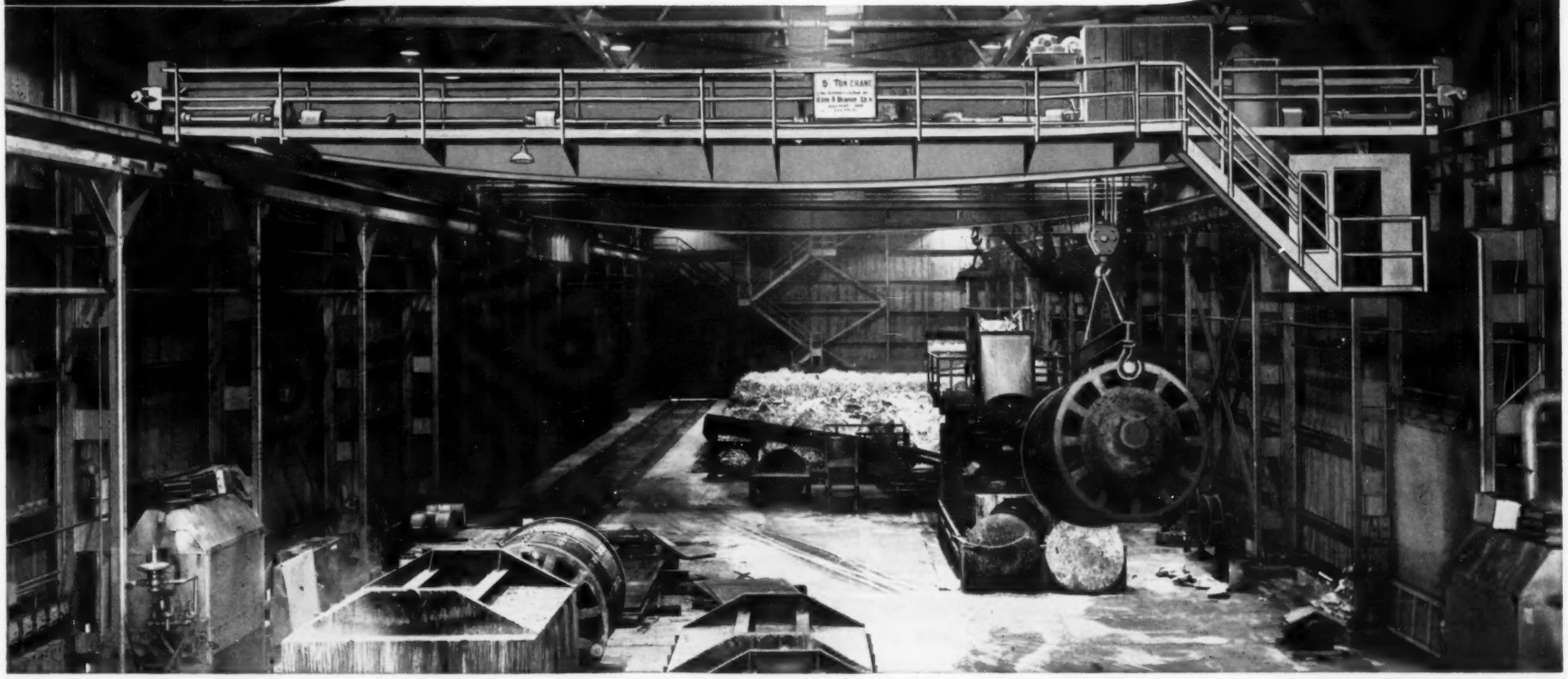
DESIGNERS AND BUILDERS OF ELECTRIC OVERHEAD TRAVELING CRANES AND HOISTS AND ELECTRIC REVOLVING CRANES

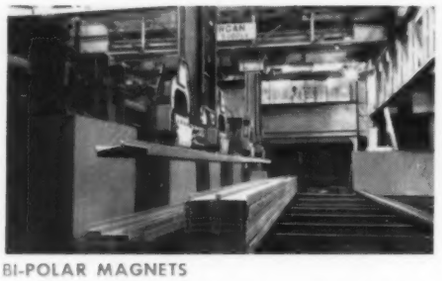


FROM START TO FINISH IN HANDLING STEEL

From scrap yard to finished product, the modern efficient way to handle metals is with a Cutler-Hammer Supermagnet . . . the first name in lifting magnets for more than fifty years!

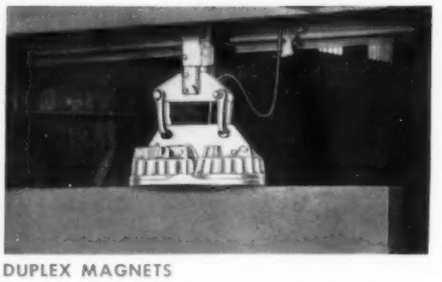
SPECIAL PURPOSE MAGNETS

Designed for specific applications, Cutler-Hammer Magnets can substantially reduce handling costs. As shown in the main illustration, Cutler-Hammer Rail Handling Magnets move multiple rails swiftly, efficiently, and safely.



BI-POLAR MAGNETS

These Cutler-Hammer Magnets are designed specifically for handling structural shapes such as I beams, angles, and channels. Cutler-Hammer Bi-Polar Magnets have played a major role in cutting the cost of classifying and stacking beams for shipment.

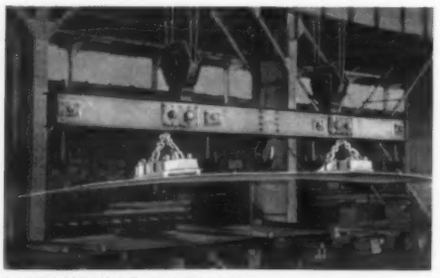


DUPLEX MAGNETS

This custom-built duplex magnet for slab turning in a scarfing department is a good demonstration of Cutler-Hammer's ability to design and build magnets for even the most varied and specialized applications.

CIRCULAR MAGNETS

Cutler-Hammer Supermagnets are known the world-over for their versatility, durability, and dependability. Perfect for handling iron or steel in any form, hot or cold, and in all kinds of weather. Available in either welded or bolted construction, sizes ranging from 39" to 77".



RECTANGULAR MAGNETS

Cutler-Hammer Rectangular Magnets provide maximum lifting capacities with minimum magnet weight . . . also save in crane equipment and daily power consumption. Perfect for regular shapes such as sheet and bar stock, etc. Heavy duty rectangular magnets recommended for handling billets, ingots and slabs.

CUTLER-HAMMER
CONTROL
C-H

To solve your metal handling problem, look to Cutler-Hammer where you are assured not only the finest magnet on the market today, but the magnet that's perfect for your needs. Write today, Dept. V232. Cutler-Hammer Inc., Milwaukee 1, Wis.

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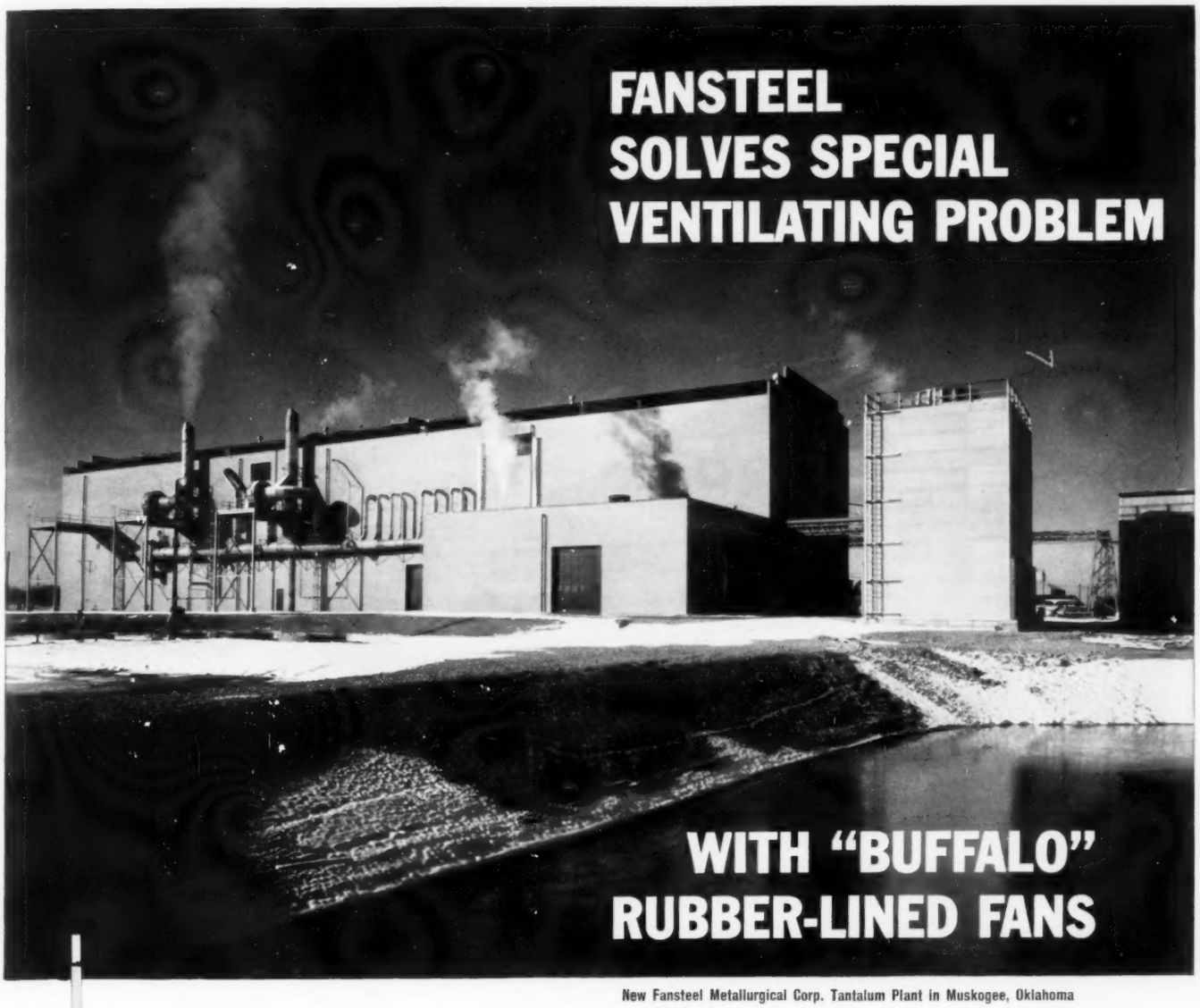
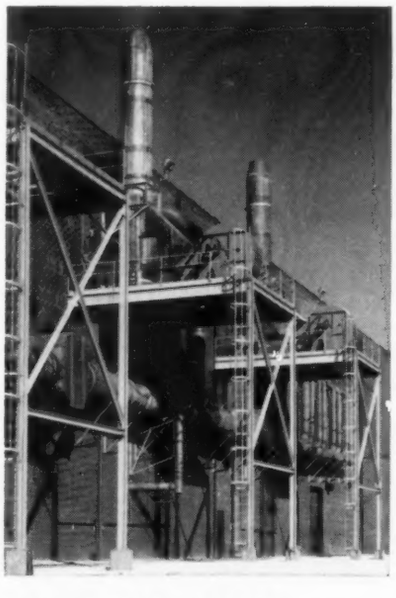
FANSTEEL SOLVES SPECIAL VENTILATING PROBLEM



WITH "BUFFALO" RUBBER-LINED FANS

New Fansteel Metallurgical Corp. Tantalum Plant in Muskogee, Oklahoma

Tantalum Capacitors like this are made from Fansteel Tantalum. They are important components of electronic, aircraft and missile systems.



"Buffalo" Rubber-Lined Fans provide efficient ventilation for the critical control necessary in the Chemical Operations Building of Fansteel's new, ultra-modern tantalum plant.

Key point in Fansteel's new facilities is the Chemical Operations Building, where the valuable metals tantalum and columbium are produced. Removing impurities and extracting the metals from the ores requires a series of precisely-controlled chemical and electrochemical operations.

Where air handling is so important, it is understandable that Fansteel should turn to "Buffalo", whose 81 years of engineering experience assures satisfactory ventilation under critical conditions.

"Buffalo" Rubber-Lined Fans are noted for their ability to withstand many years of punishing service. Rubber is vulcanized to all parts of the fan exposed to the air stream. There is no possibility of separation, hardening or cracking. Savings in down-time and fan parts more than pays for the slight extra cost of the rubber.

Whatever the type of severe service *your* fans may encounter, there is probably a "Buffalo" Fan to handle the job. Contact your nearby "Buffalo" engineering representative, or write direct for Bulletin 2424-F today.

BUFFALO FORGE COMPANY
BUFFALO, NEW YORK

"Buffalo"

Buffalo Pumps Division, Buffalo, N. Y.
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VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT
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60-DAY MONEY-BACK OFFER!

Bailey-built HEAT PROVER* Analyzer

Size: 10⅞″ W, 11¼″ H, 8¼″ D. Weight: 25 lb.

*Registered Trademark

Here's the easy, low-cost way to fuel savings through complete combustion analysis.

This portable, but extremely accurate instrument, instantly measures the volumetric percentages of oxygen and combustibles present in furnace and waste gases. It precisely determines fuel-air relations, so you can make adjustments for optimum combustion efficiency.

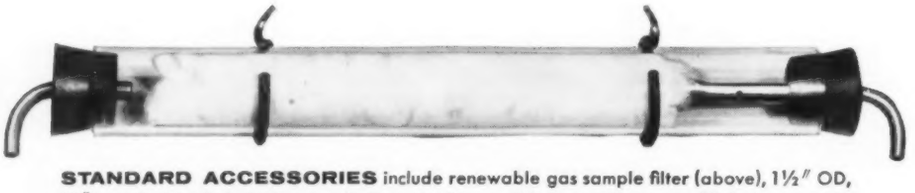
Try it for 60 days. If you're not convinced it will, in short order, pay for itself in fuel savings, return it, and we'll refund your money.

Look at these features:

- **Ranges: Oxygen: 0 to 4%, and 0 to 20%; Combustibles: 0 to 4%, and 0 to 20%; Temperature: 0 to 2500°F; 115v/60c service.**
- **Accurate within ±0.5% on 0-20% scale; and 0.1% on 0-4% scale by volume of oxygen and combustibles in gas sample.**
- **Response: Indicating gages respond to 63% of total change of oxygen and/or combustibles in less than 15 seconds.**
- **No separate fuel supply to become exhausted and require replacing. HEAT PROVER automatically generates its own hydrogen supply for oxygen measurements. Addition of distilled water is only requirement.**
- **Provision included for temperature measurement, using chromel-alumel thermocouple.**
- **Born of 20 years' experience with gas analyzers.**

$980.00

Includes HEAT PROVER and Standard Accessories.
Offer valid in continental United States only.



STANDARD ACCESSORIES include renewable gas sample filter (above), 1½″ OD, 12″ length. Also included: convenient, protective, padded carrying case, 50 ft. heavy-duty power cord, 8 oz. sodium hydroxide solution for hydrogen generator, and instruction book.

To order or for additional information, call your local Bailey District Office or write us direct.

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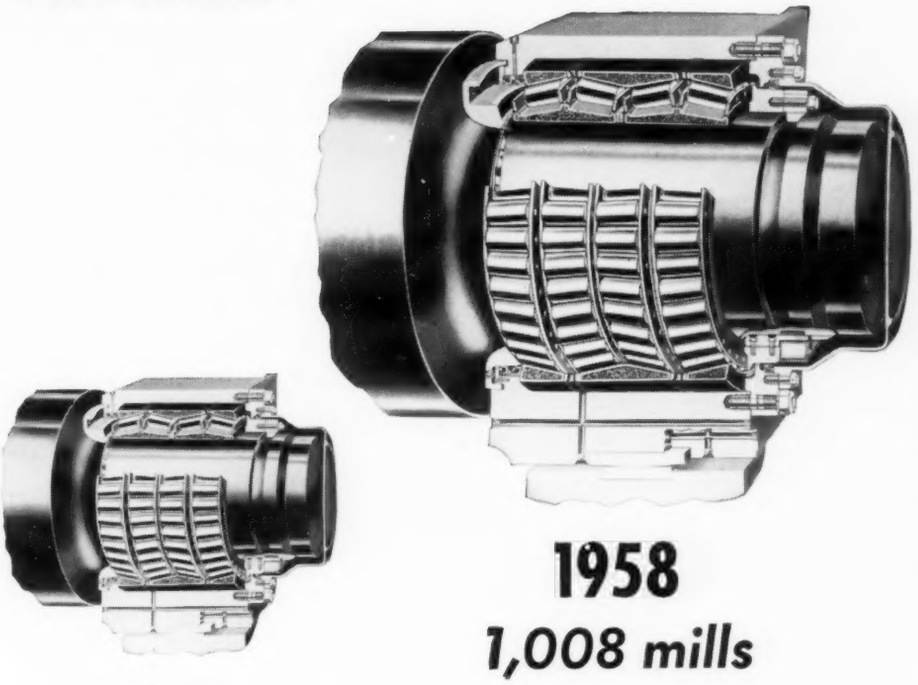
TIMKEN® bearings used on rolling mill roll necks



1933
45 mills

1950
317 mills

1958
1,008 mills

Look how this idea has grown in 25 years!

JUST 25 years ago—in 1933—there were 45 mills using Timken bearing-equipped stands. Today, 2,436 Timken bearing-equipped stands are used in 1,008 mills . . . more than 22 times as many mills as in 1933.

Why has the idea of using Timken® tapered roller bearings on mill roll necks become so widely adopted? For all these reasons:

1. LOW BEARING COST. Tonnage records indicate that the long life of Timken roll neck bearings keeps bearing costs per ton of steel rolled to a minimum.

2. GREATER MILL RIGIDITY. Balanced proportion design of Timken bearings permits larger roll necks than ever before possible with tapered roller bearings.

3. ELIMINATION OF COMPLICATED LUBRICATING SYSTEMS. Timken bearings permit use of simple grease lubrication.

4. LOAD RATINGS INCREASED UP TO 40% due to Timken bearings' balanced proportion design.

5. NO SPECIAL THRUST BEARINGS NEEDED. Timken tapered roller bearings take both radial and thrust loads.

6. MILLS CAN BE STOPPED AND RESTARTED WITH NO LOSS OF STEEL. Timken bearings permit starting under full load.

7. HIGHER ROLLING MILL SPEEDS are possible because Timken bearings minimize friction.

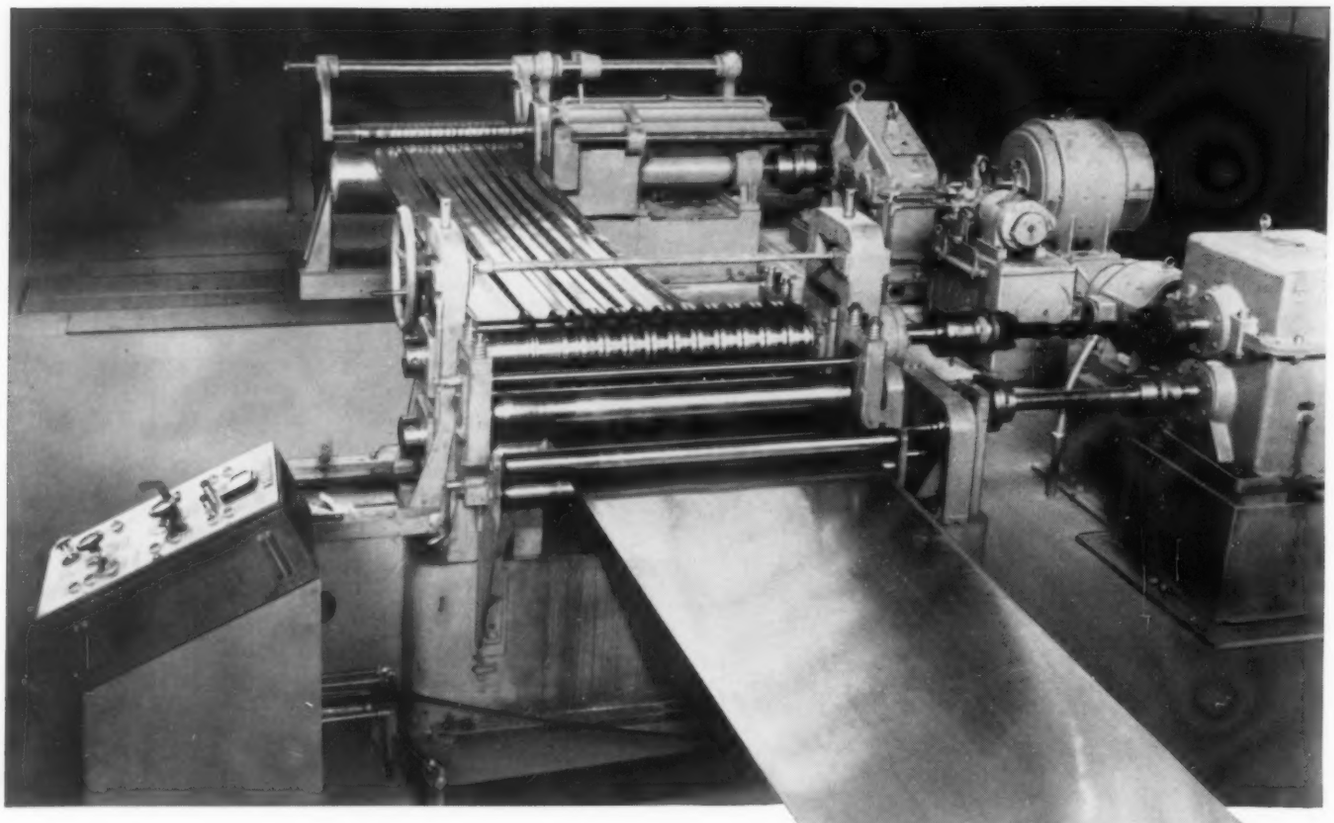
8. PROLONGED ROLL LIFE is assured because Timken bearings provide maximum roll neck strength, less wear.

You can be sure of all these advantages in either existing or new equipment by specifying Timken tapered roller bearings for back-up and work rolls. Consult our roll neck bearing specialists for full details. Write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS ROLL THE LOAD



Greater Profit and Operational Flexibility with a YODER SLITTER

Even if you use less than 100 tons of varied strip sizes per month, it will pay you to investigate the savings that are possible through the operation of a Yoder slitter. Savings per ton increase rapidly as coil size and width of strands decrease . . . so much, that under average operating conditions, a slitter will pay for itself in a few months.

From a small stock of standard mill-width coils, a Yoder slitting line enables you to meet unexpected demands, or to supply "special" width slit strands in a matter of a few hours. This flexible operation increases plant efficiency, resulting in savings of time and money through simplified production planning and greatly reduced strip inventories.

The Yoder line includes slitters of every size and capacity for coil or sheet stock. Send for the all-new, 1958 edition of the Yoder Slitter Book. It is a comprehensive text on the mechanics and economics of slitter operations with time studies, cost analyses, and other valuable data. Write to:

THE YODER COMPANY

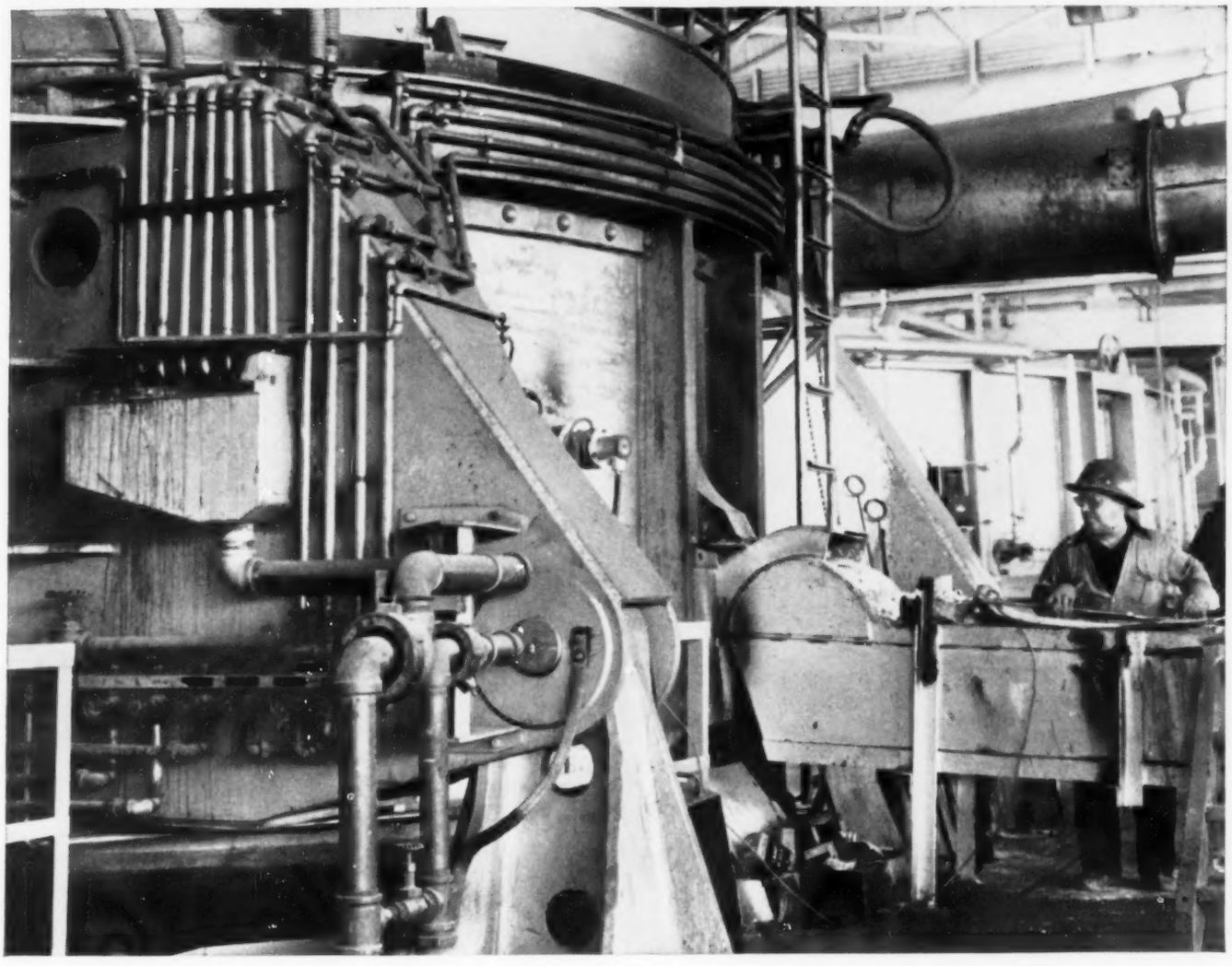
5495 Walworth Avenue • Cleveland 2, Ohio

ENGINEERING YODER MANUFACTURING

ROTARY SLITTING LINES

PIPE AND TUBE MILLS (ferrous or non-ferrous)

COLD ROLL FORMING MACHINES



From the World's Largest Copper-Melting Electric Furnace

TOP QUALITY CASTINGS...ROCK BOTTOM COSTS

Whiting Hydro-Arc Electric Furnace at the Perth Amboy, N. J. plant of American Smelting and Refining Company pours a ton of copper every two minutes—24 hours a day, 7 days a week. Operating costs are competitive, even in this area of high-priced electric power.

Hydro-Arc offers you the *precise* temperature control that assures a top quality product—be it copper, iron, steel, or any other metal or material. You will save money, too, because continuous melting boosts production . . . top-charging reduces downtime . . . simplified design cuts maintenance costs . . . and Hydro-Arc costs less installed than other equipment of equal capacity. For prime melting or duplexing get the facts on Hydro-Arc.

SEND FOR NEW 8-PAGE BULLETIN EF-100

telling all about the electrode arm and clamp which floats on a cushion of air and which is clamped by a cushion of air. Booklet is fully illustrated. *Whiting Corporation, 55156 Lathrop Avenue, Harvey, Illinois.*

Member of the Foundry Equipment Manufacturers Association

87 OF AMERICA'S "FIRST HUNDRED" CORPORATIONS ARE WHITING CUSTOMERS

WHITING

FOUNDRY EQUIPMENT

MANUFACTURERS OF CRANES; TRAMBEAM HANDLING SYSTEMS; TRACKMOBILE; FOUNDRY, RAILROAD AND CHEMICAL PROCESSING EQUIPMENT

Another Rolling Mill Operated
Automatically by.....
The operation of this 110-inch Reversing Slabbing Mill is controlled by EC&M's Punched Card Automatic Positioning Screwdown Control System

THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

EC&M PUNCHED CARD CONTROL

Since 1937, EC&M has been the pioneer in the development of Automatic Positioning Screwdown Control Systems. With EC&M's Punched Card System of scheduling, new operators can be quickly trained to produce greater tonnage to accurate tolerances—automatically. Since rolling is automatically maintained to specifications issued by the Metallurgical Department, the highest quality of the finished product is assured.

With EC&M's Punched Card System of automatic rolling, the operator can easily change from automatic to manual control and back again. To change schedules, a new card is inserted in the card reader. Cards can be stored and re-used when an identical rolling schedule is needed.

The EC&M Automatic Positioning Screwdown Control System can be furnished with Direct Reading Card System, IBM Card System or Slider Type Schedule Panel.

***Write** for Bulletin 6550*
for complete information

A single card containing the schedule for all passes is easily inserted in the Card Reader. With the card in place, the operator, by pressing a single pushbutton once for each pass, positions the rolls accurately. There is no schedule to memorize.

This 168-inch Reversing Roughing Mill is also equipped with EC&M's Punched Card Automatic Positioning Screwdown Control System

1794

NEW!

Spher-Align

SPHERICAL ROLLER BEARING PILLOW BLOCK

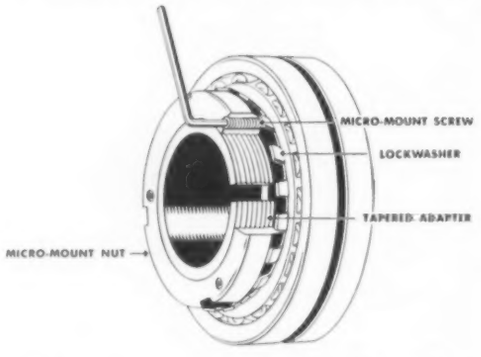
Dodge, the nation's leading supplier of mounted bearings, presents America's newest spherical roller bearing pillow block . . . a rugged bearing in attractive modern design . . . inherently self-aligning . . . easy to install . . . easy to maintain . . . and featuring the unique Micro-Mount.

Its rugged housing of close-grained semisteel withstands shock loads. It has a generous lubrication reservoir—for oil or grease. And standardized dimensions make Spher-Align interchangeable with all other similar units.

Expansion and non-expansion types. Stocked for 2 7/16" to 8" shafts. Call your Dodge Distributor—or write us.

DODGE MANUFACTURING CORPORATION
5900 Union Street, Mishawaka, Indiana

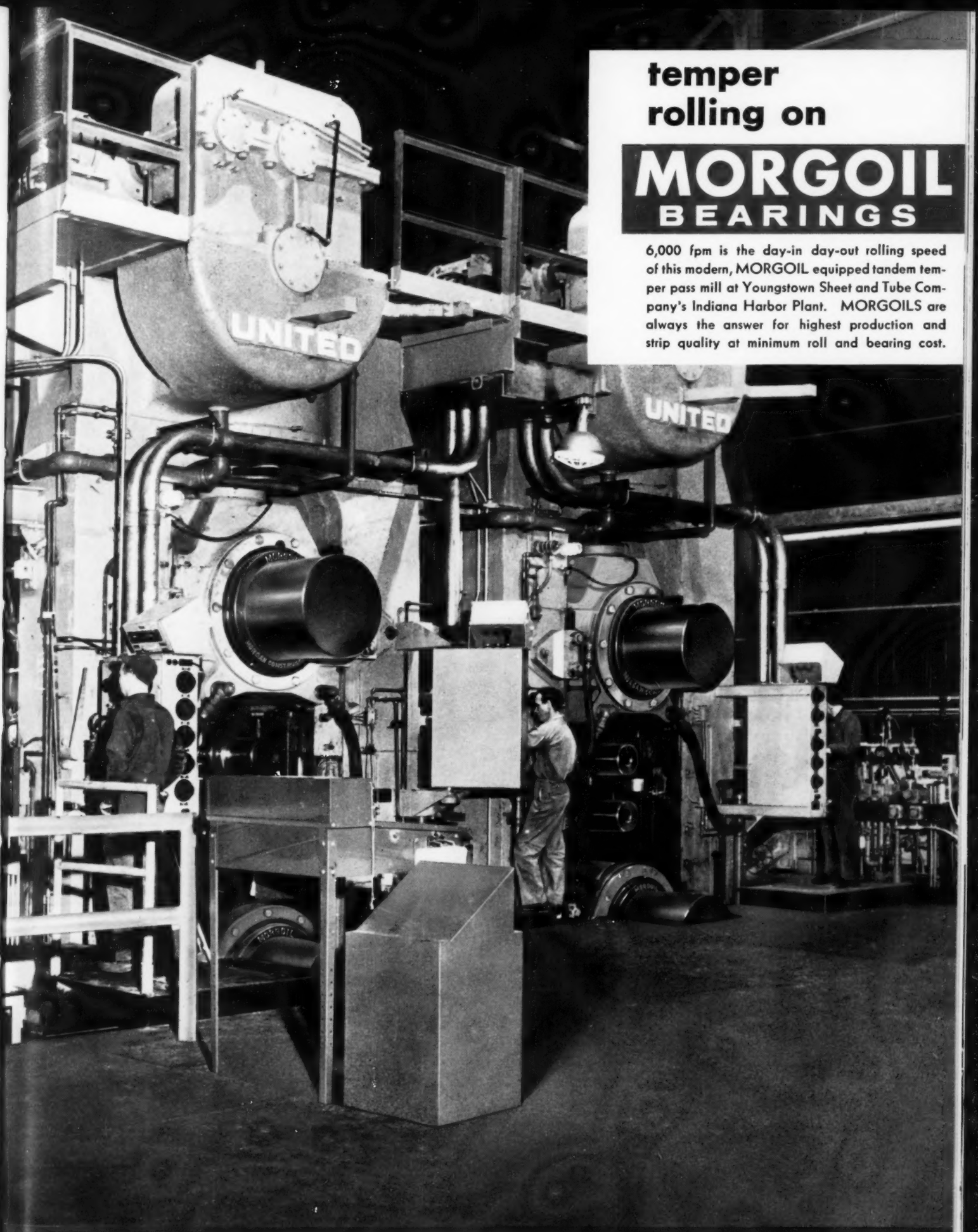
Exclusive MICRO-MOUNT



Fast and accurate mounting is made possible by the new Dodge Micro-Mount. The Adapter is snugged up with the Micro-Mount Nut. Mounting is completed by turning the Micro-Mount Screws against the Lockwasher until bearing, adapter and shaft form an integral unit.

DODGE
of Mishawaka, Ind.

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."



temper rolling on MORGOIL BEARINGS

6,000 fpm is the day-in day-out rolling speed of this modern, MORGOIL equipped tandem temper pass mill at Youngstown Sheet and Tube Company's Indiana Harbor Plant. MORGOILS are always the answer for highest production and strip quality at minimum roll and bearing cost.

MORGAN CONSTRUCTION CO., WORCESTER, MASSACHUSETTS

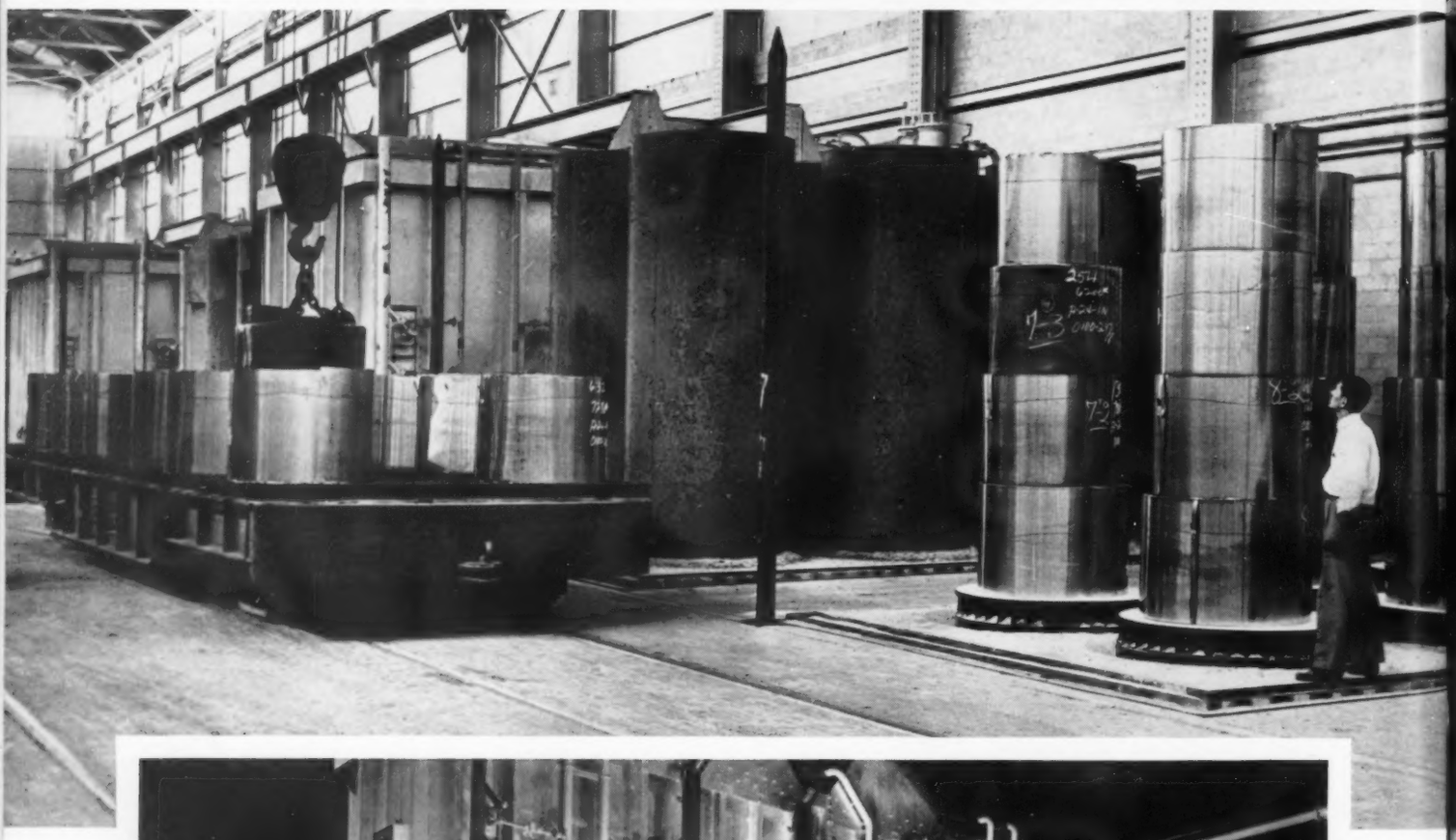
ROLLING MILLS • MORGOIL BEARINGS • GAS PRODUCERS
WIRE MILLS • EJECTORS • REGENERATIVE FURNACE CONTROL

MB 34

SWINDELL

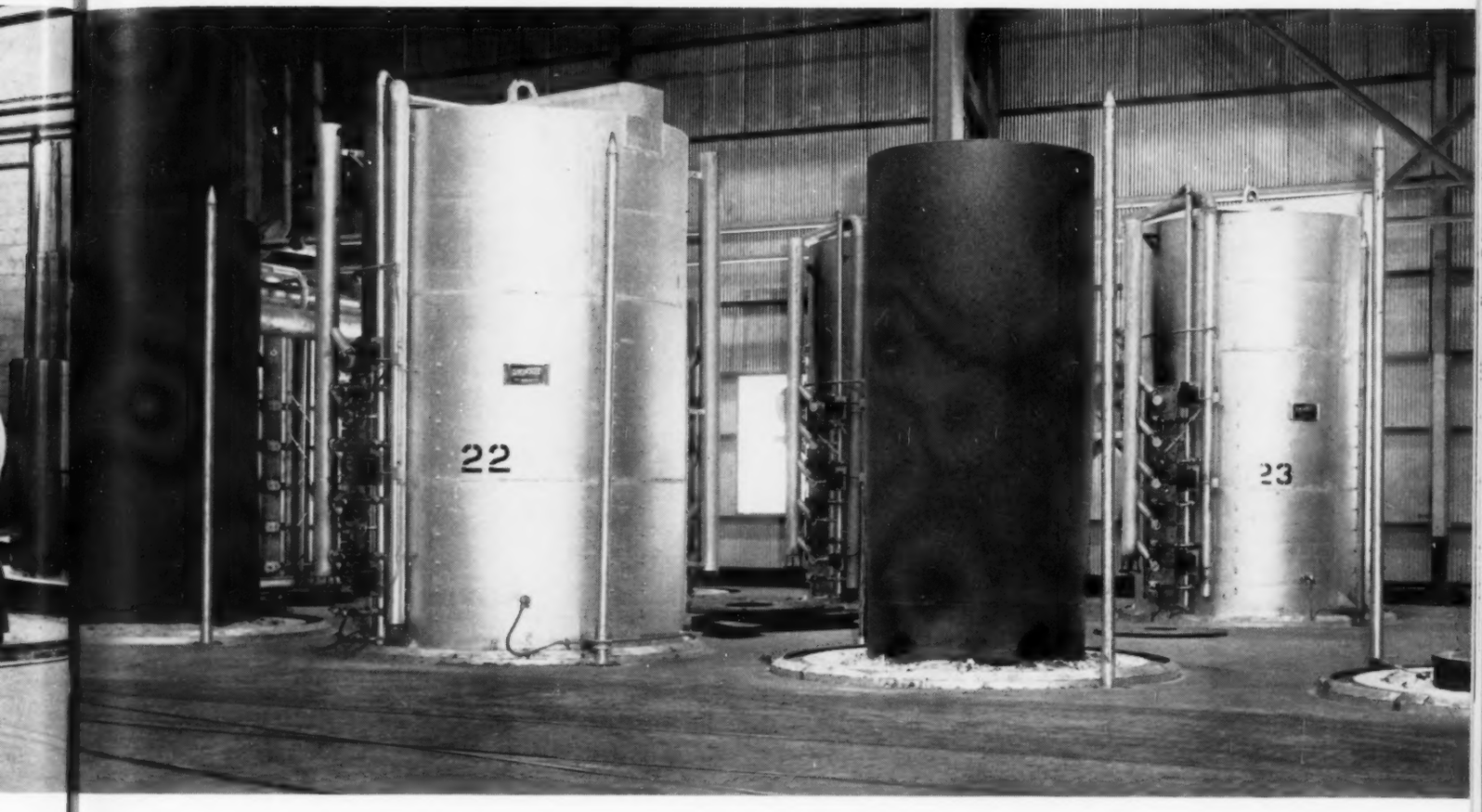
Multi-Stack and Single-Stack

ANNEALING FURNACES



- for better operating efficiency
- and better customer service—

EQUIP WITH BOTH!



Here's why:

When you equip with *both* Swindell Multi- and Single-Stack Annealing Furnaces in the same shop, you profit!

- You render more effective service to your customers because better equipment flexibility enables you to handle efficiently a greater variety of jobs.
- Additional efficiency is gained because operating techniques and procedures are similar for both types.
- You save in parts inventory and maintenance because burners, load bases, inner covers and other major components are interchangeable throughout.

A SWINDELL-DRESSLER engineer will be pleased to provide further information!

SWINDELL-DRESSLER Corporation

DESIGNERS AND BUILDERS OF MODERN INDUSTRIAL FURNACES

PITTSBURGH 30, PA.

This man is tabling downtime indefinitely with SKF's new steel pillow blocks

He's cutting bearing maintenance to a minimum yet drastically reducing the chances of table downtime! For he's equipping the mill tables with SKF's new SMT Steel Pillow Blocks with self-aligning spherical roller bearings.

The split construction design of these new pillow blocks makes it possible for rolls to be removed without disturbing base alignment. The non-rubbing, labyrinth-type seal effectively keeps out scale and water and is not affected by high temperatures.

The Type "C" Spherical Roller Bearing gives him the highest capacity available in any self-aligning roller bearing. This high capacity is available despite angular misalignment caused by heat warpage of the table structure or other factors promoting table misalignment.

He'll save with direct, center lubrication, too . . . because a lubricating groove is provided around the circumference of the outer ring of SKF sphericals with equally spaced holes drilled in the ring connecting the groove to the center of the bearing. Grease moves around the groove and through the holes which channel it directly to the center of the bearing.

Why not make the change-over to SKF Steel Pillow Blocks yourself? Write for Catalog #447.

7821

Spherical, Cylindrical, Ball, and "Tyson" Tapered Roller Bearings

EVERY TYPE—EVERY USE

SKF®

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

® REG. U. S. PAT. OFF.

OPERATION upturn
Buy now for extra values
GENERAL ELECTRIC

COMPUTER PROGRESS

Digital and Analog Computers at Work

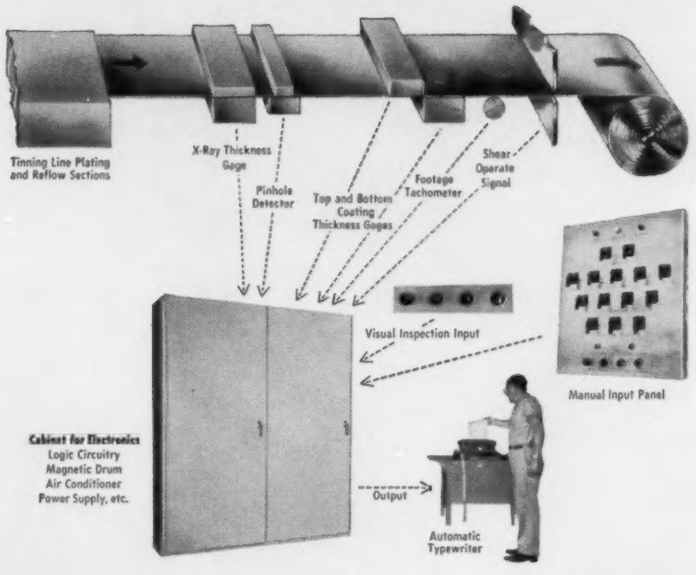
ARTICLE 3 VOLUME 1

SOLVING A TINPLATE INSPECTION AND BILLING PROBLEM WITH MODULAR COMPONENTS

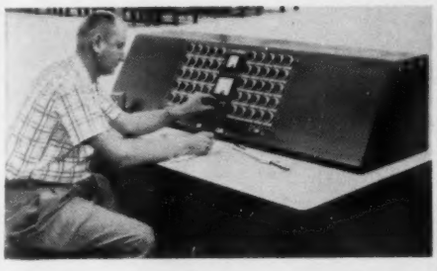
The trend towards purchasing tinplate direct in large coils rather than in sheets brings about a change in inspection techniques. No longer is it possible to separately inspect each sheet; instead, inspection must now be done at line speed on the delivery end of the tinning line. As complete coils of tinplate will now be shipped to the customer, steel companies will need permanent, accurate defect records.

General Electric is now solving this problem for several tinplate producers by *automating* their data logging with the new Model 302 Automatic Inspection Data Accumulator for Tinplate. This system provides a complete, typewritten record for quality control and billing purposes immediately upon completion of each coil.

Unlike many computers installed in factories, the G-E Data Accumulator is designed specifically for an industrial environment, not for office use. Modular electronic units are mounted on strong, 3/16 inch metal frames in completely enclosed cabinets. The all-transistorized plastic coated printed circuit plug-in cards are easy to repair; maintenance costs are reduced since cards may be replaced, and spare parts stock is kept small.



In addition, an exclusive new magnetic drum application cuts out approximately 60% of previously required electronic gear. Not only does the reduction in complexity increase reliability, but the space and dollar saving also allows sufficient duplication of circuitry for constant cross-comparison of data. Preventive maintenance can be performed on one section while the other continues to log data. Magnetic storage also eliminates the danger of losing stored data if power fails.



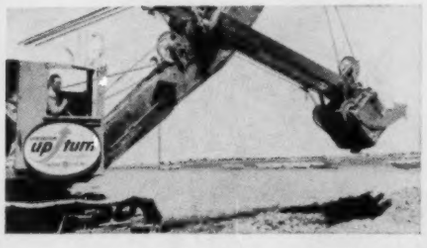
ONLY 8 HOURS INSTRUCTION REQUIRED TO OPERATE PRODUCTION SCHEDULING COMPUTER

The new G-E 306 desk-size analog computer, designed to solve office and factory production and business problems, can be operated by the average clerical worker after only 8 hours instruction.

The computer is used wherever multiplication of a number by each of fifty coefficients and the summing of the results is required. Up to twenty-four such numbers may be multiplied with one setting of dials. Manufacturing problems such as production scheduling, materials explosion and work station load impact studies, as well as business problems like budget syntheses and operating reports (or any other first order linear equation problem) may be solved.

A typical solution takes only 2 minutes. The unit operates on 115 volts.

COMPUTER DEPARTMENT LAUNCHES OPERATION UPTURN WITH NEW MILLION-DOLLAR PLANT IN PHOENIX, ARIZONA



General Manager H. R. Oldfield, Jr., is pictured at the controls of the Operation Upturn steam shovel which recently broke ground for the new 104,000 square foot permanent plant which is expected to be completed by December of 1958.

"Our business is good and getting better," Oldfield said. "We're going to continue to expand during the year, adding perhaps a hundred or more people." The department now has over 800 employees.

The 160 acre site is located in Deer Valley Park, northwest of Phoenix along the west side of the Black Canyon Highway and south of the intersection with Thunderbird Road.

For more information, contact your nearest General Electric Apparatus Sales Office, or Computer Department—Room 102, General Electric Company, 1103 No. Central Avenue, Phoenix, Ariz.

CPA—9

Progress Is Our Most Important Product

GENERAL ELECTRIC

GENERAL REFRACTORIES

Breakthrough in

GREFCO'S
STEELKLAD 40-EE

the roof of the "All-Basic" open hearth furnaces now breaking production records.

• This year, improved operating techniques and greater use of oxygen in open hearth furnaces have yielded unprecedented increases in production. Two years ago, a production rate of 25 ingot tons per hour was considered satisfactory for large open hearths. Today, many of these same furnaces produce 40 tons per hour, and rates up to 50 tons per hour are deemed entirely possible.

These improvements, however, place such increased stress on roof refractories that silica brick cannot endure. Only "All-Basic" furnaces can withstand these operations satisfactorily.

"STEELKLAD 40-EE", the first internally plated brick, has made possible the phenomenal growth in the number of "All-Basic" furnaces. In early 1956, only two "All-Basic" furnaces existed in North America. By January of this year, there were 15. At present, over 50 furnaces are or will shortly be of "All-Basic" construction. And of this total, more than 80% have roofs of "STEELKLAD 40-EE" refractory brick.

• *GREFCO leads the Refractories Industry in "All-Basic" furnaces, with radically new "EE" and "Tab" brick.*

• *Simplified basic constructions, using "Tab" and "EE", drastically cut "All-Basic" furnace costs.*

• *GREFCO technical and sales service personnel are ready to help you build such furnaces, whether of sprung, suspended, or combination roof construction.*

For basic brick tailored to your installation, and for the know-how and experience to use them properly . . . Get GREFCO!

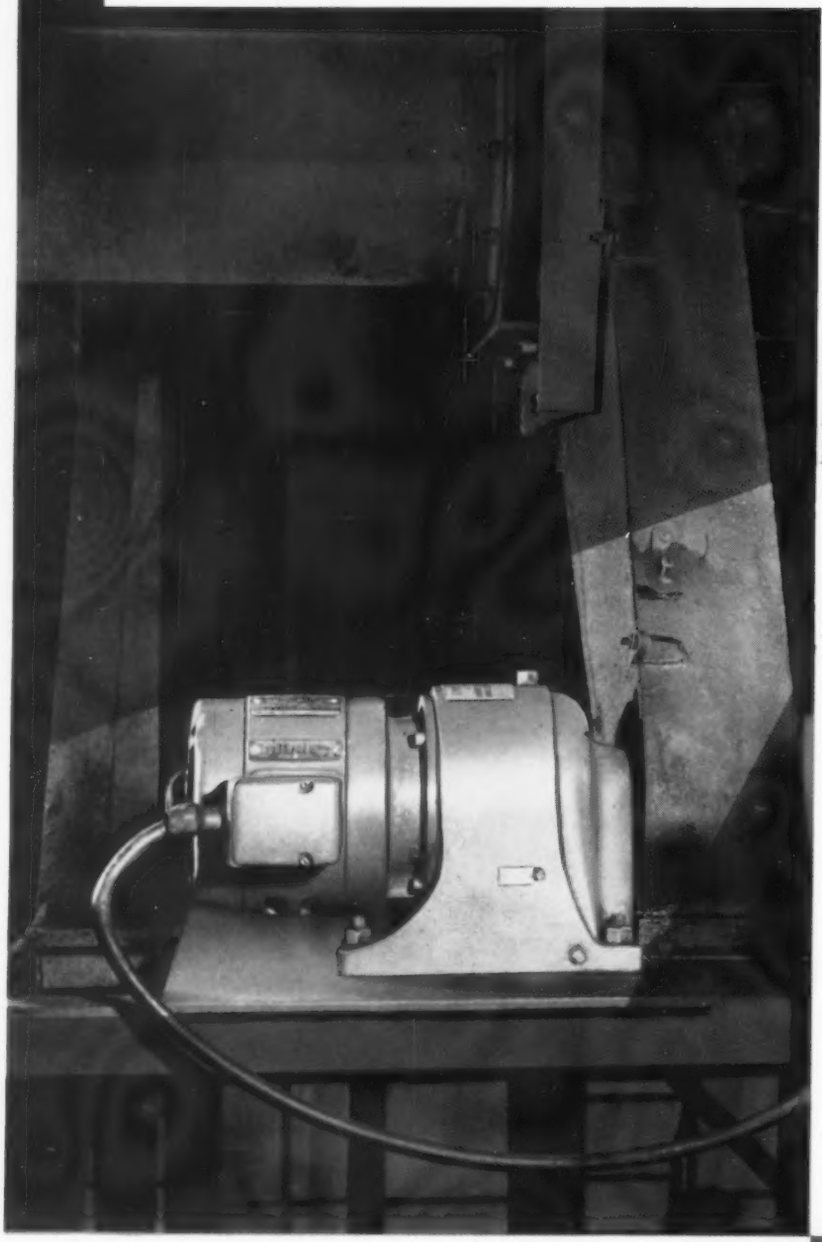
GENERAL REFRACTORIES COMPANY

Philadelphia 2, Pa.

A COMPLETE REFRACTORIES SERVICE

(*At left*) A new roof of "STEELKLAD 40-EE" converts this open hearth furnace to "All-Basic" construction, and permits vastly increased production, at lower cost.

Tight space? Perfect place for a Link-Belt Gearmotor



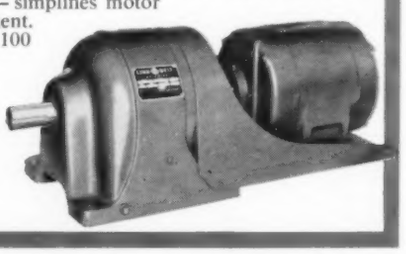
Maintains life-long alignment with flange-mounted NEMA motors

Here's a speed reducer right in step with industry's campaign for higher productivity in less space. Because its gear trains incorporate a minimum of parts . . . because its motor is directly connected to the gear drive with a flange—the Link-Belt Gearmotor is the ultimate in compactness.

Imagine how these same features cut costs. The flange connection eliminates additional coupling devices. Simple gear trains have fewer parts to wear, to service, to invite trouble.

You'll find them in Book 2447. Call your authorized Link-Belt stock-carrying distributor or nearby Link-Belt office.

LINK-BELT MOTOGEAR—for bracket-mounting all makes and enclosures of foot-type NEMA motors — simplifies motor replacement. Sizes to 100 hp.



LINK-BELT

SPEED REDUCERS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14.806

Steel plant reports on use of B&W Kaocrete-32 in critical sections of electric furnace roofs:

•36% saving in installation time

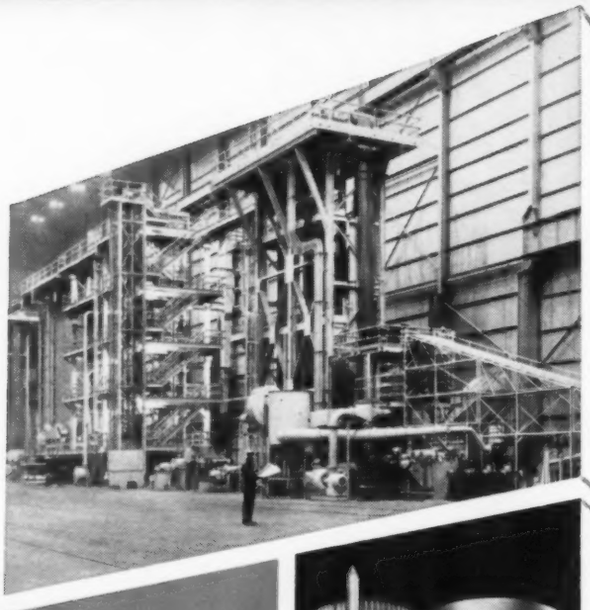
•42% increase in roof life

•20% reduction in refractory costs

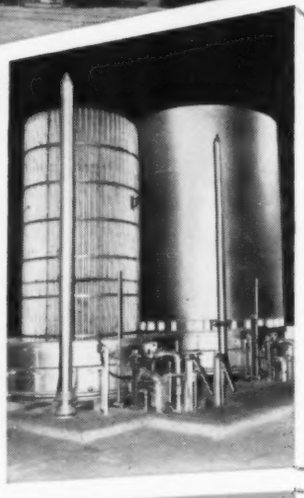
For further information on how you can profit with B&W Kaocrete-32 in electric furnace roofs, consult your B&W refractories representative or send for technical bulletin RR-46.

B&W REFRACTORIES PRODUCTS: B&W Allmul Firebrick
• B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick
• B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide
• B&W Ramming Mixes • B&W Kaowool

BABCOCK & WILCOX
THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42ND ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

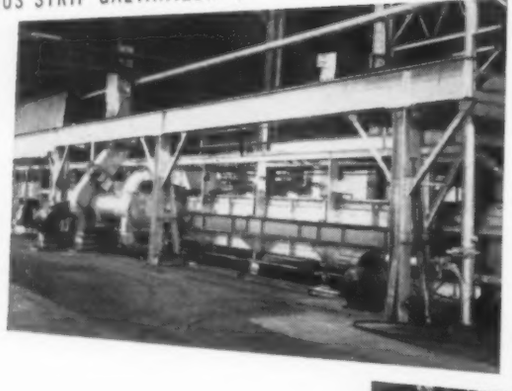


VERTICAL STRIP ANNEALER



SINGLE-STAND ANNEALERS

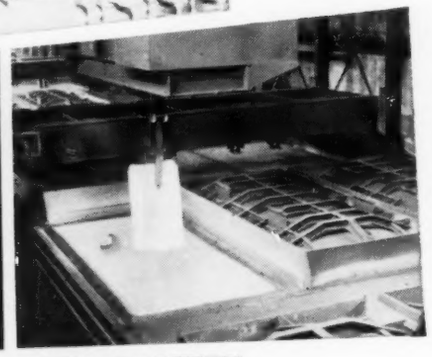
CONTINUOUS STRIP GALVANIZER



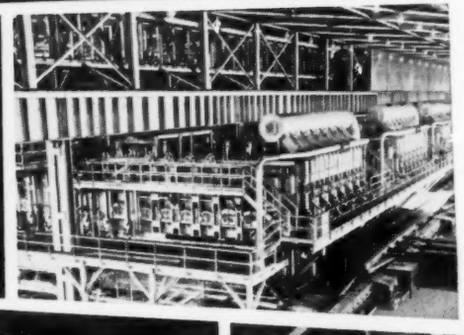
MULTIPLE-STAND ANNEALERS

foundation for steel mill profits

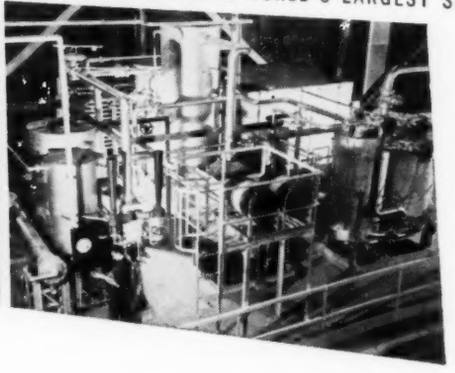
CARBOTTOM COVER FURNACE



ONE-WAY FIRED SOAKING PITS



WORLD'S LARGEST SLAB HEATER



HNX® GAS GENERATOR

You put a solid foundation under your profits whenever you specify Surface equipment. Whatever type it may be, you know it is supported by many interlocked blocks of know-how in heating and handling steel.

The technical skills which Surface has developed in building soaking pits will benefit the man who buys Surface annealing covers. In the same way, Surface concepts of slab heating contribute to high-speed stress relieving . . . carbon restoration to strip annealing . . . controlled atmospheres to wire patenting.

Because of this broad and deep foundation of experience, Surface can improve any single process in the context of a complete sequence of operations. This is to the customer's profit, as many companies will confirm.

Surface Combustion Corporation, 2404 Dorr St., Toledo 1, Ohio. In Canada: Surface Industrial Furnaces, Ltd., Toronto, Ontario.

Surface®

wherever heat is used in industry

ASSOCIATED COMPANIES: British Furnaces, Ltd., Chesterfield • Stein & Atkinson, Ltd., London • Stein & Roubaix, Paris • S. A. Belge, Stein & Roubaix, Bressoux, Liege • S. A. Forni Stein, Genoa • Chugai Ro Kogyo Kaisha, Ltd., Osaka

BIRDSBORO *tapered neck* ROLLS

help **broaden** *profits!*

B

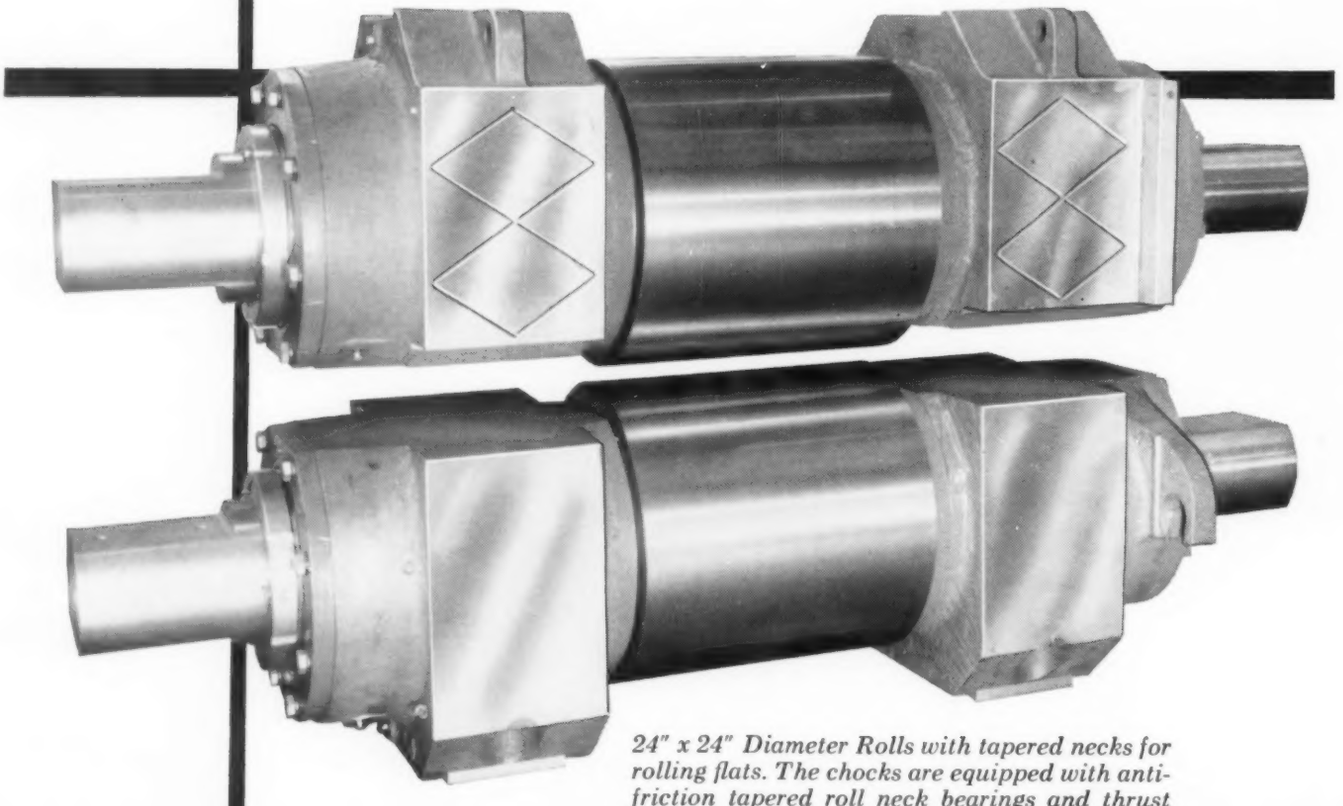
• It was a job that required the utmost precision . . . a job worthy of the talents of Birdsboro's roll engineering service group.

Birdsboro manufactured the rolls, the housing, and assembled the entire unit. Birdsboro engineers insured the client's investment in the rolls and assured the kind of economical service that will show up in profit figures. It takes precision in roll engineering to build the profit picture you need for today's production. Birdsboro will appreciate the opportunity to help you attain that precision. *Main Office, Engineering Department and Plant:* Birdsboro, Pa., *District Office:* Pittsburgh, Pa.

R.-26-58

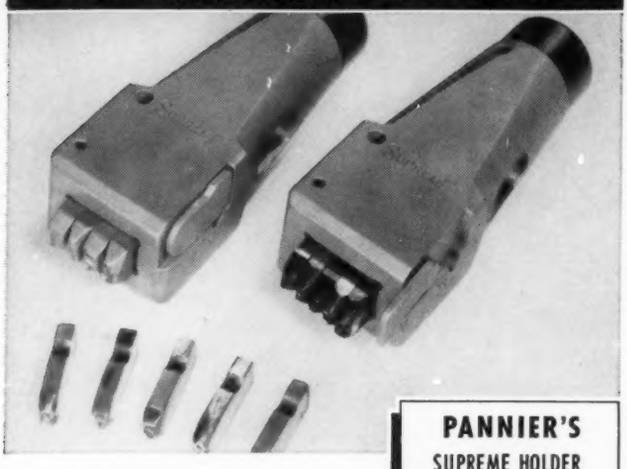
BIRDSBORO
STEEL FOUNDRY AND MACHINE CO.

STEEL MILL MACHINERY • HYDRAULIC PRESSES • CRUSHING MACHINERY • SPECIAL MACHINERY • STEEL CASTINGS • Weldments "CAST-WELD" Design • ROLLS: Steel, Alloy Iron, Alloy Steel



24" x 24" Diameter Rolls with tapered necks for rolling flats. The chocks are equipped with anti-friction tapered roll neck bearings and thrust bearings. Bottom chocks are equipped with four (4) hydraulic roll balance jacks.

ANOTHER *PANNIER* MASTER MARKER!



New Roto-Pin type lock is integral part of *all* Pannier Supreme Holders . . . eliminates loose, bent, dropped, or lost pins . . . flip it open to change type . . . flip it back to securely lock type in clear-marking position.

PANNIER'S
SUPREME HOLDER
WITH ROTO-PIN LOCK

Safe, fast type changing. Holder in variety of styles. Machined from High-Grade Bar Tool Steel. Hardened anvil maintains type alignment. Striking Head of Tool Steel . . . Replaceable to add long service life to Holder.

Write for complete data.

BIRTHMARKED MATERIALS

MARKING DEVICES

MASTER PANNIER MARKERS

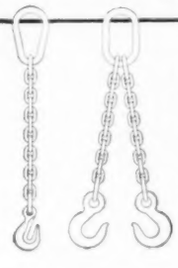
THE PANNIER CORPORATION

302 Pannier Building • FAirfax 1-5185 • Pittsburgh 12, Pa.

Offices: Los Angeles • Chicago • Cleveland • Philadelphia • Birmingham

HERC-ALLOY

The Original Alloy Chain



● An all-purpose chain for use where strength and safety are primary considerations.

● Sold in running lengths, slings assembled to customers' specifications and other special assemblies.

● Write for Bulletin 100 covering Herc-Alloy Sling Chains, including helpful information on their care, use and inspection.

● CM also produces welded chain of all types including stainless steel and bronze.

CM HOISTS AND CHAIN

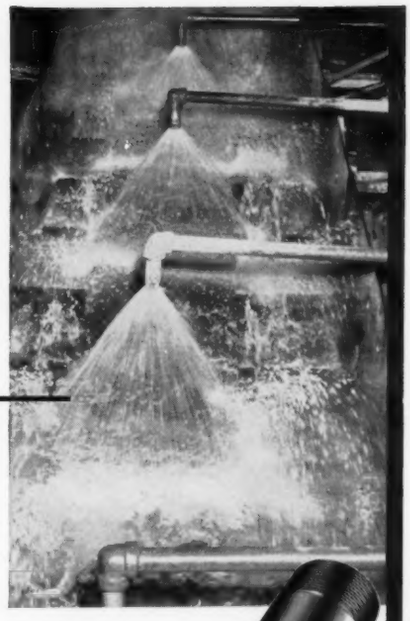
COLUMBUS McKINNON CHAIN CORP.

TONAWANDA, NEW YORK

Regional Offices:
NEW YORK • CHICAGO • CLEVELAND

In Canada: McKinnon Columbus Chain Ltd., St. Catharines, Ont.

every installation a complete success

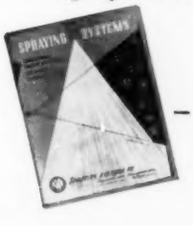


with Spraying Systems Co.

Spray Nozzles

for hot strip spray cooling descaling roll cooling and related operations

● Greater spraying efficiency and lower equipment and maintenance costs are the advantages Spraying Systems Co. spray nozzles give you. Nozzles for hot strip cooling for example, give better steam barrier penetration and spray distribution . . . remove more heat per minute per gallon of water. Descaling nozzles provide greater impact for any volume and pressure without excessive cooling. Non-clogging design and recommended types of mounting are features that help reduce maintenance costs. Your inquiry is cordially invited for Spraying Systems Co. spray nozzle data and application information.



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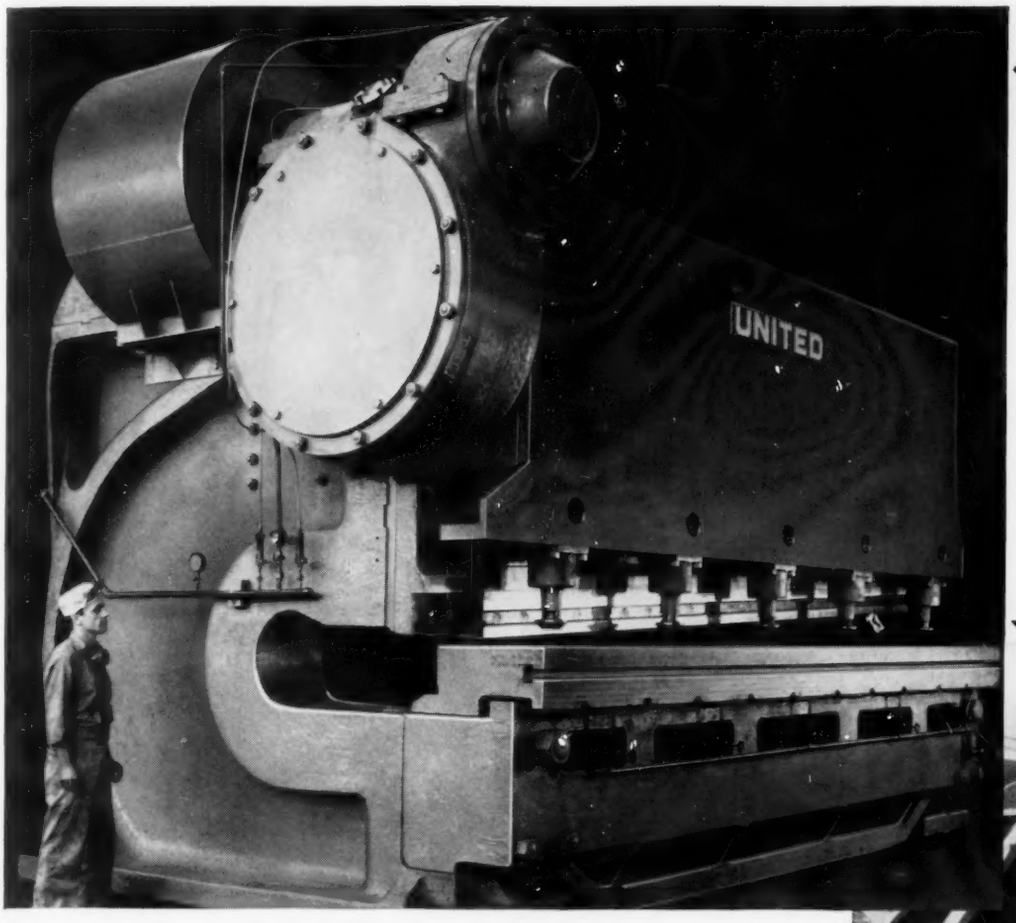

Fig. 1—United's 630,000 psi Cone-Drive geared shear is more compact and streamlined and has a higher capacity than the spur-gear driven shear. Cone-Drive gears are enclosed in compact housing in foreground.

Fig. 2—An older model of a similar shear shows the bulky conventional spur gear drive at the top of the machine.

WORM GEARED SHEAR CUTS 1 9/16" STEEL PLATE UP TO 13' WIDE

An idea of what double-enveloping worm gearing can contribute to steel mill equipment is told, in part, by the accompanying photographs. Fig. 1 shows a United Engineering and Foundry Company 630,000 lb. shear operated through Cone-Drive gearing. Fig. 2 shows an older similar shear—but actually of smaller capacity—driven through conventional spur gearing.

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3. Flywheel clutch unit and motor mounted to give more effective machine operation.

4. Service difficulties have been eliminated. Only an occasional check on lubricant is now required.

5. Much quieter and smoother operation.

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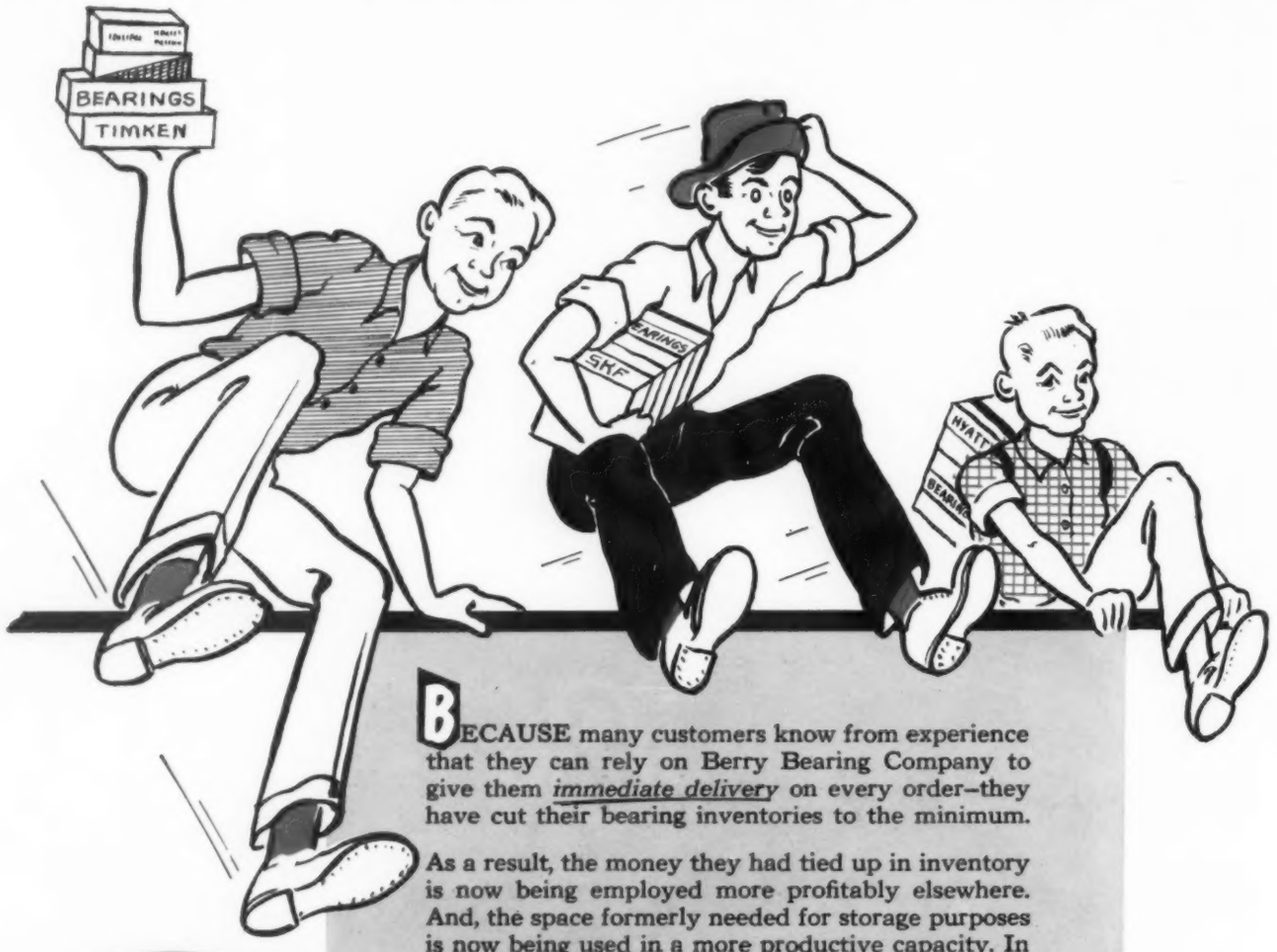

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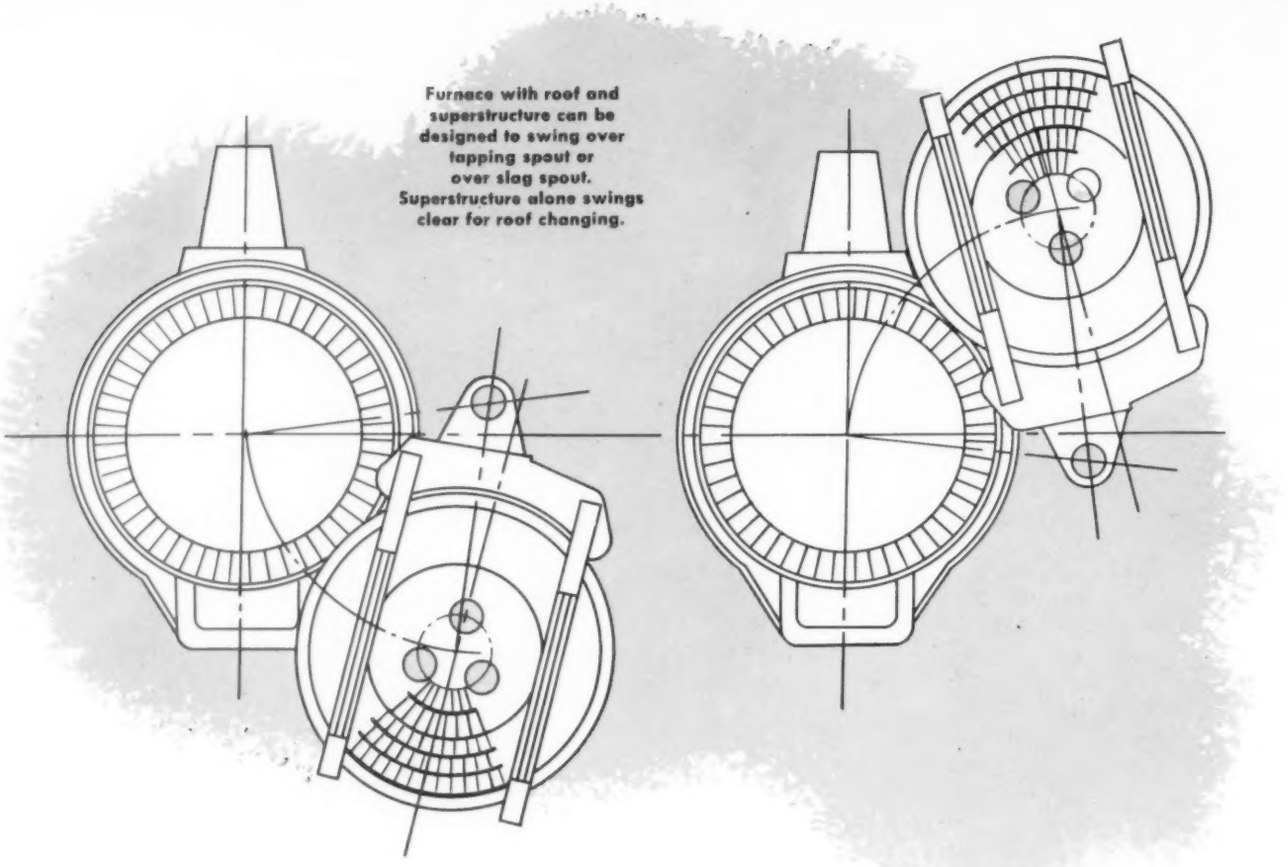
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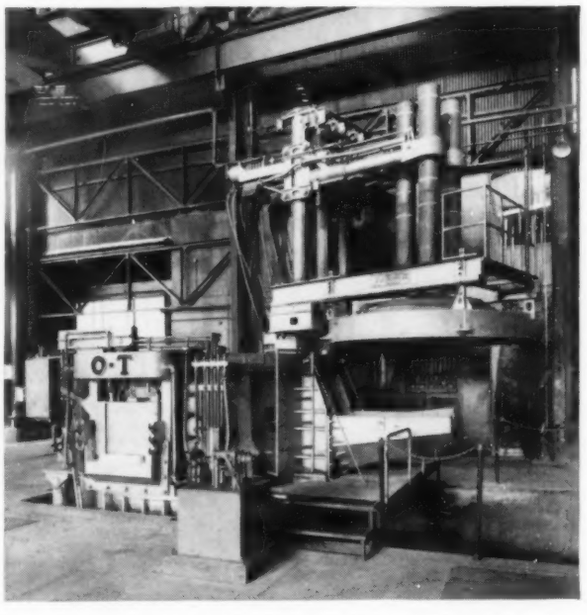

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Carbon Black In Fuel Oil
for open hearth furnaces

by G. W. Teskey, Jr., Superintendent—Open Hearth
Bethlehem Pacific Coast Steel Corp., San Francisco, Calif.

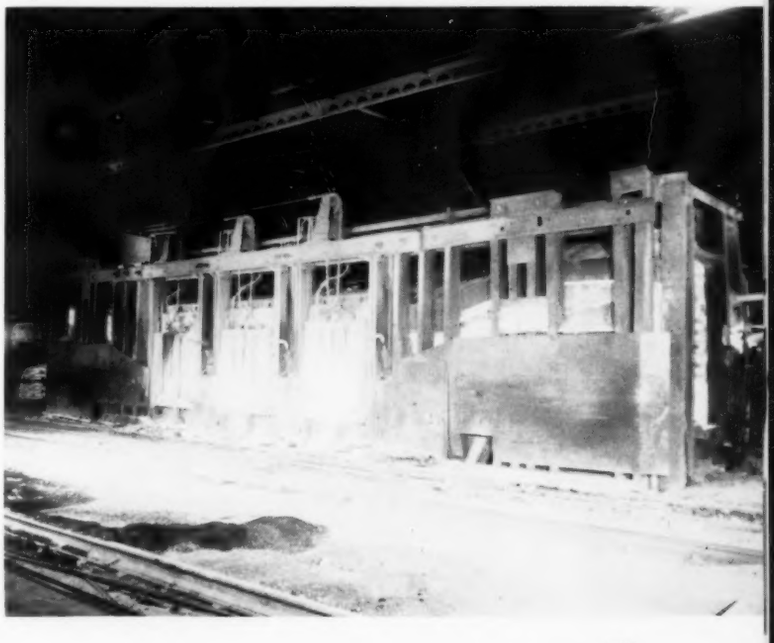
Improved furnace production was obtained through the addition of carbon black with an improvement of about 1.5 per cent for each per cent of carbon added . . . . production runs were made on small open hearth furnaces using a light fuel oil in a 50 per cent oil and 50 per cent natural gas flame.

IN an open hearth furnace heat is transferred to the charge from the fuel and products of combustion principally by convection and radiation. Radiant heat transfer becomes dominant when high temperatures, such as in an open hearth, are required. The radiation required to develop a charge temperature of 3000 F is obtained primarily by using a luminous flame. This radiation is a function of the spectral emission bands of the hot gases, the solid particulate matter in the flame, and the reflection from the enclosure.

There are at least two basic ways to increase flame radiation; one is to raise the temperature, the other to increase the flame emissivity. Since most open hearths are operated near the fusion temperature of their refractories, an increase in temperature, while improving heat transfer, will usually have a detrimental effect on the brick life. Increasing flame emissivity to improve radiation is generally a safer approach when considering the furnace refractories. Previous attempts in this direction have been to increase the carbon to hydrogen ratio of the fuel. The increase in productivity experienced in some open hearth shops burning tar or pitch is, at least in part, attributed to the higher carbon to hydrogen ratios of these fuels.

In an effort to increase open hearth productivity at the South San Francisco plant of the Bethlehem Pacific Coast Steel Corp. early in 1953, one furnace was placed on a trial run using Bunker C fuel oil. At that time, a light fuel oil (PS-300) was being used. Due to the physical arrangement of the plant, as well as the fuel handling facilities, it was not economically practical to use Bunker C oil on a full production scale. However, the results of this test were encouraging in that increased production resulted. It was believed that part of the increase was due to the use of a fuel with a greater carbon to hydrogen ratio. From this trial the idea of adding carbon to the PS-300 fuel oil was conceived. It was felt that if this could be accomplished, a more luminous flame would result, which in turn would improve the heat transfer characteristics of the flame and thereby increase productivity.

Figure 1 — Shop has five 75-ton basic furnaces.



* The following are co-contributors to this paper: E. G. Chilton, D. L. Doughty and L. B. Kahn of the Shell Development Co. and G. W. Teskey, Jr., E. H. Swett and W. L. Murphy of the Bethlehem Pacific Coast Steel Corp. U. S. Patent No. 2780538 has been issued to the Shell Development Co. covering the fuel described in this paper.

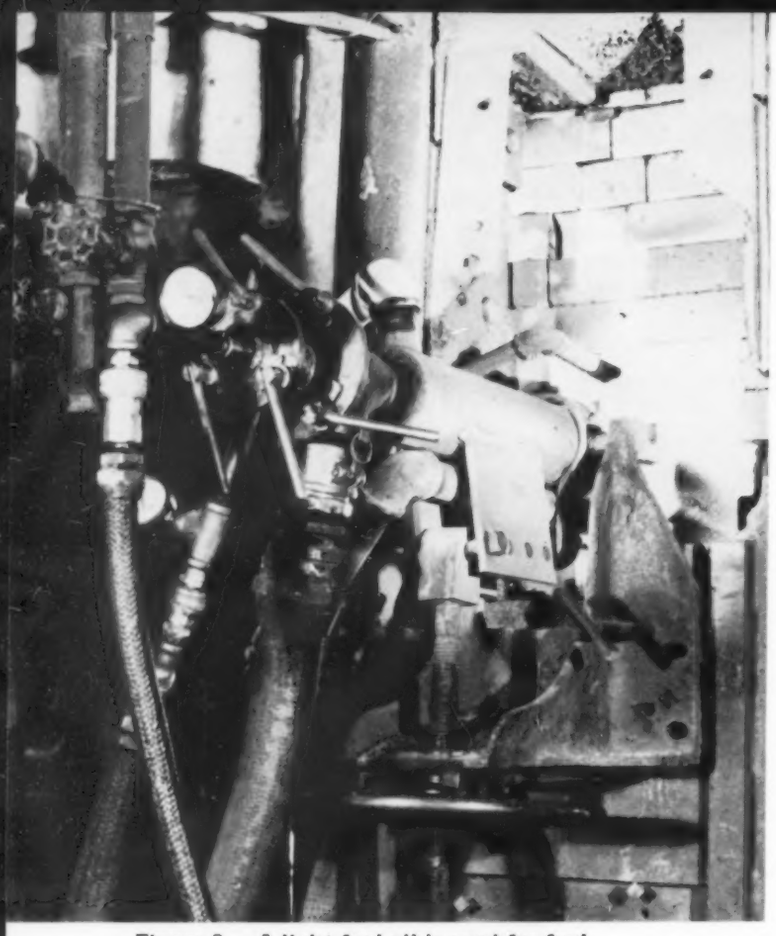
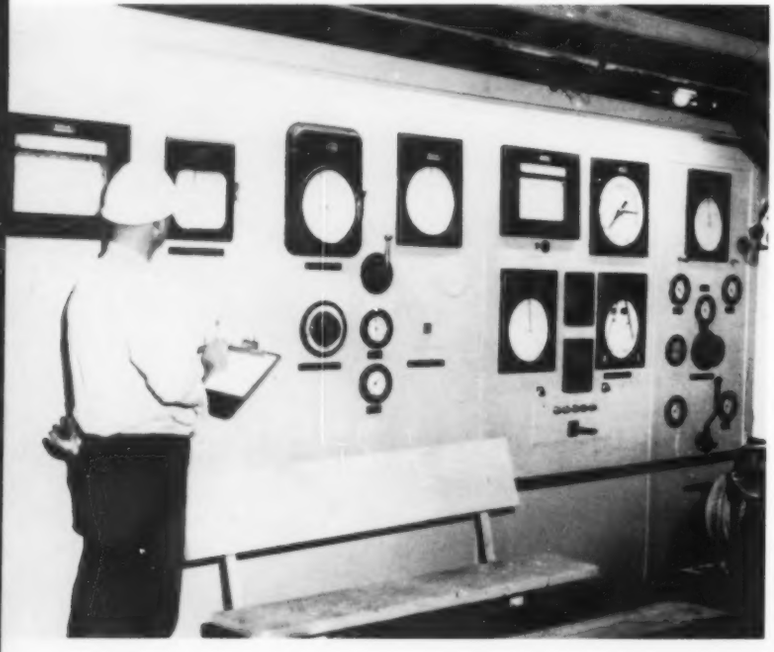


Figure 2 — A light fuel oil is used for fuel.

Before proceeding further with the discussion of this fuel and the experimental trials, it is believed that a brief description of the shop facilities is in order. Figure 1 shows a typical furnace, of which there are five. The furnaces are 75-ton basic, cold metal, open hearths producing rimmed, killed, and semi-killed steels. The ingots are bottom and top cast and are rolled into bars, bar size shapes, structural shapes,

Figure 3 — Furnace reversal is automatically controlled by time and temperature.



reinforcing bar, and forging billets. The year to date production rate is 8.9 tons per hr, or 23.9 tons per hr per 1000 sq ft of hearth area.

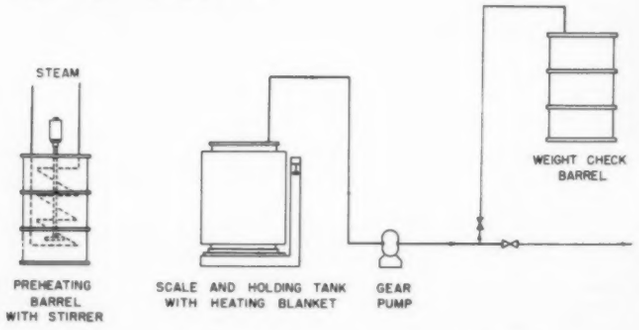
Figure 2 shows a typical burner installation. This is the same burner used for the carbon fuel oil tests. It may be observed that it is a quick disconnect type requiring no tools to disassemble.

Figure 3 shows a typical furnace control panel. The furnace reversal is automatically controlled by time and/or temperature and the furnace pressure is recorded and regulated by an automatically positioned damper. Natural gas and fuel oil are also recorded and controlled at this panel. Approximately 50 per cent natural gas and 50 per cent light fuel oil, atomized with compressed air, are fired at a combined rate of 44,000,000 Btu per hr.

The first step in creating the synthetic fuel was to determine the type and form of carbon to be used. It is known that, for a given weight of carbon, the smallest particle size would have the largest surface area and would theoretically result in the best radiator This immediately eliminated the powdered coal having a size of approximately 20 to 200 microns. Carbon black, such as that made by cracking natural gas, having a particle size of 0.02 to 0.5 microns, appeared most promising despite its higher cost. In addition, the published literature indicated that pulverized coal suspensions had been tried without substantial success. This synthetic fuel was then made in a ball mill by mixing one part by weight of carbon black with one part by weight of PS-300 fuel oil. It should be noted that almost any grade of fuel oil could be carbon enriched, but since PS-300 was being fired at the time, it was decided to continue with its use. This concentrate could then be added to the normal fuel stream to yield the desired amount of carbon enrichment.

Figure 4 shows a schematic sketch of the initial equipment arrangement. The carbon oil concentrate was received in 50-gal drums which were preheated with a steam coil immersed in the supply tank, after which they were delivered to the furnace where they were placed on a scale and wrapped with an electric blanket. The concentrate was pumped directly into the fuel stream from the drum with a gear pump, while the weight of addition was controlled by a tachometer on the pump and periodic scale weight checks. Since the concentrate was added to the fuel stream ahead of the metering control orifice, the total quantity of fuel to the burners remained constant at 44,000,000 Btu per hr. Handling and operating dif-

Figure 4 — Flow diagram shows original concentrate heating and pumping plant.



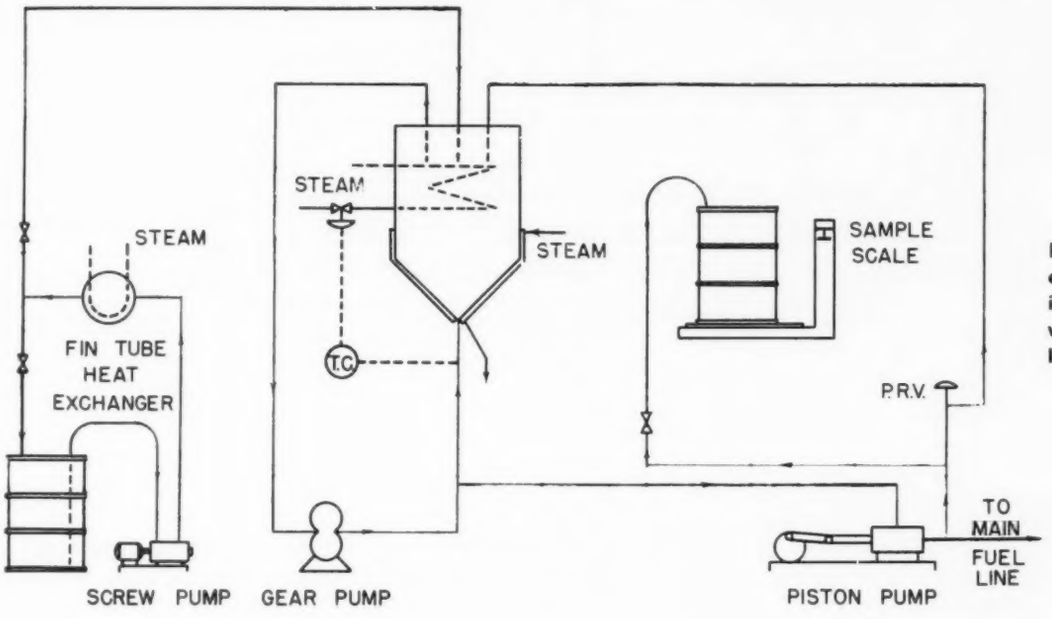


Figure 5 — A more elaborate concentrate heating and pumping plant was eventually established.

ficulties as well as insufficient pumping capacity made the preliminary setup undesirable.

During 1954 and 1955 a more elaborate concentrate handling facility was installed. A flow diagram of this arrangement is shown on Figure 5. In this setup the oil is added to a holding tank from which it is recirculated through a fin tube heat exchanger before pumping into the fuel stream. Figures 6 and 7 of this installation show the holding tank, pumps and heat exchanger. Using a positive displacement pump with micrometer stroke adjustment, a maximum of 54 gphr, or 12 per cent carbon by weight, could be injected into the fuel stream.

The concentrate was heated to 190 F which was the same temperature as the main oil supply. The pumping pressure was approximately five per cent more than the line pressure. A typical burner is shown in cross section in Figure 8. The oil is atomized through a number of straight hole nozzles in the burner head at the forward end of the burner. Natural gas, at 24 psig, is added concentrically about the atomized oil and the mixture issues from a water cooled 1¼-in. diam nozzle into the furnace.

The preliminary tests were to determine if the

Figure 6 — A maximum of 12 per cent carbon by weight can be injected into the fuel stream.

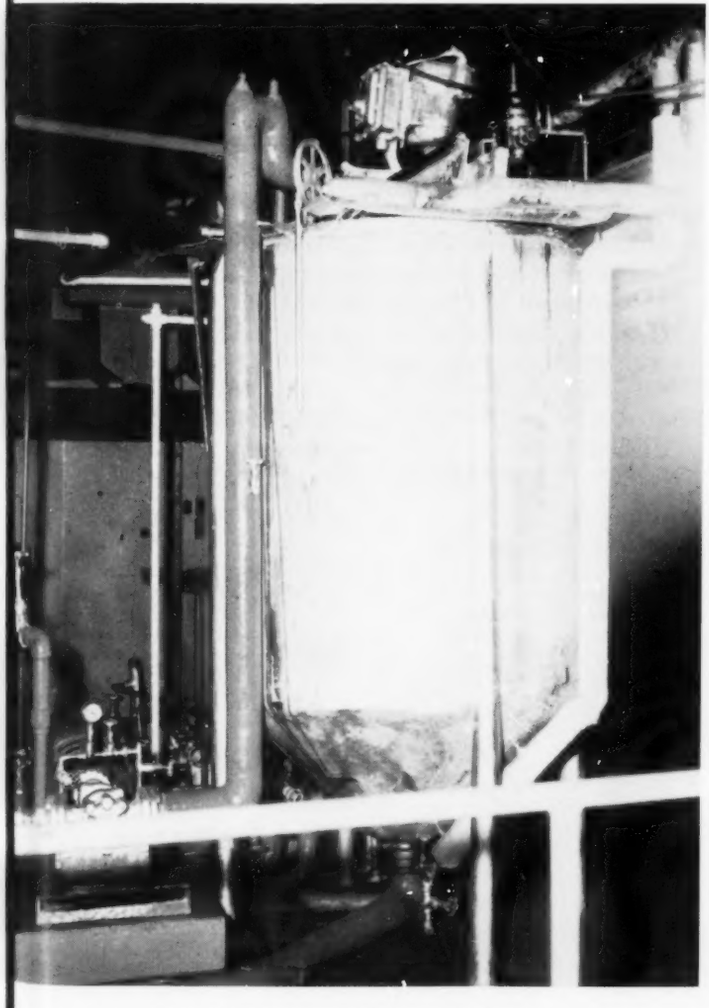


Figure 7 — Pumps are positive, displacement type with micrometer stroke.

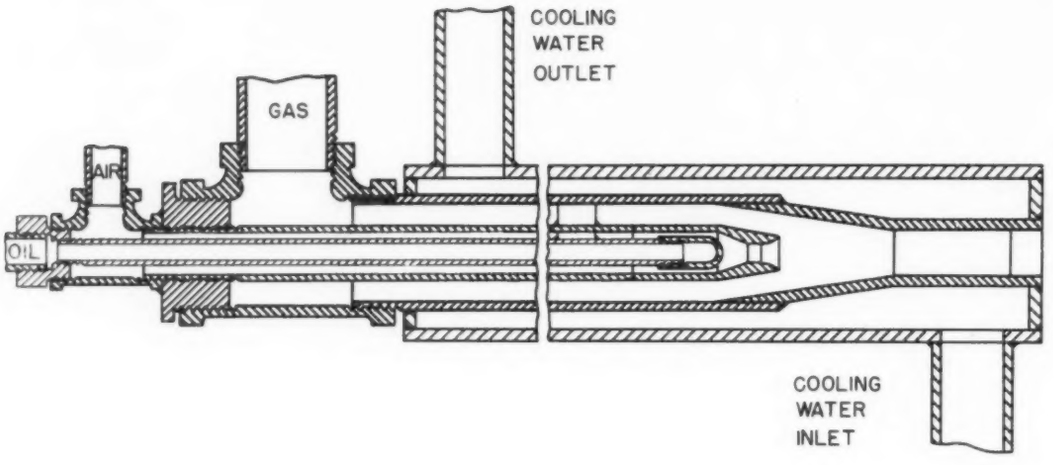


Figure 8 — Cross section through burner.

addition of carbon had a noticeable effect on the performance of an open hearth furnace. The use of one per cent and 2.5 per cent carbon did not appear to change the flame characteristics. However, when increasing the carbon addition to five per cent, an appreciable change in flame shape and luminosity occurred. Twenty tests, ten with and ten without a five per cent carbon addition, were made while firing all oil. The results are shown on Table I, Test 1. As a check on the visual observations, ten heats, alternately with and without carbon, were also run at 2.5 per cent carbon. See Test II of Table I. A third series of tests were conducted using a 50 per cent oil and 50 per cent natural gas flame. The amount of carbon added was five per cent as in the first series. The results of this test are shown on Table I, Tests III and IV.

In order to minimize charging variables, human variables, and furnace aging, all precautions were taken to supply materials to the test furnace without delay, to select the most experienced crews of operators with an engineer in attendance at all times, and to alternate carbon and noncarbon runs. In addition, other procedures were followed to make the results as reliable as possible. This will be explained later.

After improving the concentrate injection facilities, two further tests were made using a part oil, part gas flame. The first series of approximately sixty heats, in groups of ten, alternately with and without five per cent carbon, was to determine if there were any significant carry-over effects from one heat to another. In addition, there was a desire to see if the fuel would adversely affect refractory life or checker deposits.

The second group of tests was designed to determine the relationship between the amount of carbon added and furnace production. Seventy-two heats were planned, eight each at 0, 2, 3, 4, 5, 6, 8, 10 and 12 per cent carbon. The heats were divided into groups of nine. In each group, every carbon percentage was to occur once, but the order of their occurrence was randomized to avoid the influence of operational variables as much as possible. By grouping tests in this way, it was possible to assess the influence of furnace aging on the benefits derived from carbon. Previous tests had shown that an eight-fold replication would produce an adequately sized sample for statistically significant results at each carbon level. The actual amount of carbon used in each test was computed from the duration of the tests and the measured amount of concentrate used. A check was obtained colorimetrically on a mixed sample taken at the burner once an hour. During the test, the pump operation was very erratic at the 12 per cent carbon level so that no satisfactory results for this level of addition could be obtained.

While these tests were being conducted, a sample of the concentrate was sent to the University of Sheffield, England, to be tested in a model furnace used for measuring flame radiation from burning hydrocarbon fuels. This work was done under the direction of Professor M. W. Thring by Dr. D. K. Holliday.

The sample was blended with a gas oil for use in the

TABLE I
Summary of Preliminary Carbon Black-Fuel Oil Test

Test	Date	Heats[d]	Fuel	Per cent carbon addition	Average tons per hr gain	Average per cent gain	Pooled variance	T-Value	95 Per cent confidence interval for increased yield
I	9-53	10 10	Oil	5.0	0.828	9.25	0.4509	2.7574[b]	0.197–1.459
II	9-53	5 5	Oil	2.5	0.244	2.73	0.1866	0.8928[c]	0–0.875
III	2-54	11 11	Oil & gas	5.0[a]	0.556	5.76	0.1940	2.9603[b]	0.164–0.949
IV	8-55	12 13	Oil & gas	5.0	0.644	6.43	0.4424	2.4187[b]	0.093–1.195
V	10-55	30 34	Oil & gas	5.0	0.729	7.14	0.1646	2.2121[b]	0.067–1.392

[a] Based on equivalent all oil flame.
[b] Statistically significant at 95 per cent level.
[c] Not statistically significant at 95 per cent level.
[d] First figure is no. of heats with carbon, second is without carbon.

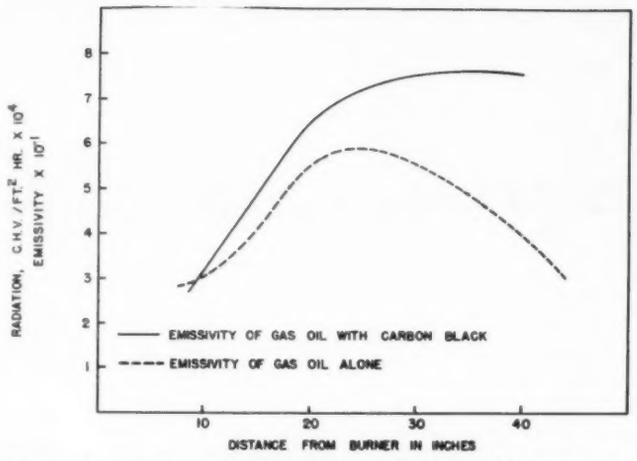

RADIATION, C H V / FT² HR. X 10⁴
EMISSIVITY X 10¹
EMISSIVITY OF GAS OIL WITH CARBON BLACK
EMISSIVITY OF GAS OIL ALONE
DISTANCE FROM BURNER IN INCHES

Figure 9 — Carbon black added emissivity which was particularly evident as the distance from the burner increased.

experimental small scale furnace to produce a fuel of low viscosity, containing ten per cent by weight carbon black. The results of this test are shown on Figure 9. The large increase in emissivity can be seen in this figure. Eliminating the first third of the flame length, the average emissivity obtained was 0.70, which compares with a predicted emissivity of the plain fuel of 0.63. It can then be concluded that the addition of solid carbon to the fuel has a greater effect on emissivity than that in the fuel as a hydrocarbon. Since this effect is most pronounced at the tail of the flame, it may be concluded that the particles of carbon black burn slower than soot produced from the decomposition of hydrocarbons. In addition, these particles persist longer in the flame, and give a high, uniform emissivity at the tail of the flame.

Since the purpose was to increase the flame emissivity, by the addition of carbon, it was desirable to measure flame temperature and emissivity in the open hearth furnace. It was possible to accomplish this measurement by the so-called "Schmidt" method. The procedure requires three radiation measurements for each determination; one reading of the flame with the hot wall background, one of the hot wall background without flame, and one of the flame against a cold wall. For this reason, three water-cooled steel plates were built into the backwall of the furnace opposite each of the three wicket holes in the charging doors. Readings, at various carbon concentrations in an empty furnace, were taken with a radiation-type pyrometer with fused-silica lens.

It is usually difficult to interpret data or to generalize from tests made in operating an open hearth furnace due to the presence of many uncontrollable and unwanted variables. Only a statistical evaluation can indicate the reliability of results. A few of the uncontrollable variables in these tests are: quality of scrap charged, difference in chemical analyses between material charged and desired steel, unavoidable delays, differences in techniques between operators, condition of furnace refractories, age and physical condition of the furnace, checker deposits, etc.

Some of the variables can be corrected on the basis of past experience as outlined in the paper presented by E. H. Swett; titled "Methods for Analyzing and Controlling an Open Hearth Operation" 1956 Proceedings AISE, p. 975. This paper discusses the effect of charging delays and difference in melt carbon and tap carbon as related to productivity. The influence of furnace aging (see Figure 10) was determined by statistical means and the effect of furnace operators was eliminated by randomizing the tests. The influence of other variables caused considerable scatter in the results at times. For this reason, it was essential that all data be scrutinized by statistical methods.

Table I shows the average results of the preliminary tests, their significance (the t value), an indication of their spread (the variance), and the range in which the results of repeated tests under similar conditions would lie with a chance of 20 to 1 (95 per cent confidence interval).

There is a significant increase in production when five per cent carbon is added. This increase appears to be greater when an all oil flame is used than with a part oil, part gas flame. With a 2.5-per cent carbon addition, the variation between tests was too great to show a significant increase, although the average shows a slight improvement.

Figure 11 is a plot of the results obtained from the final statistically designed experiment. The straight line shown seems to represent the data as well as can be expected from such tests. It passes through the confidence intervals at all carbon levels, and there is no indication that a curved line would be more reasonable.

Figure 10 — Influence of furnace age was determined by statistical means.

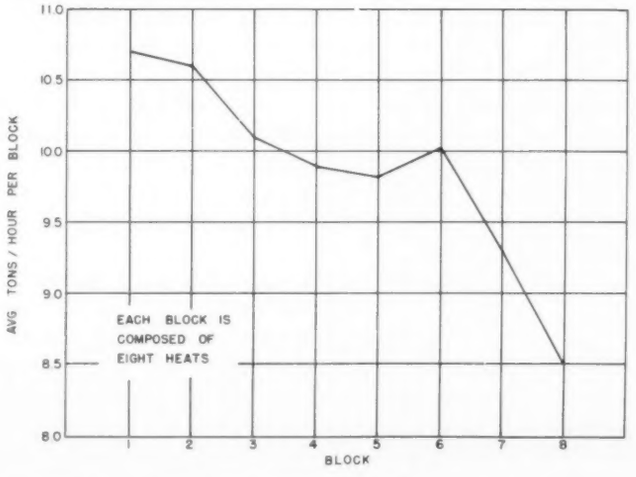


Figure 11 — Yield seems to increase proportionately to the amount of carbon added.

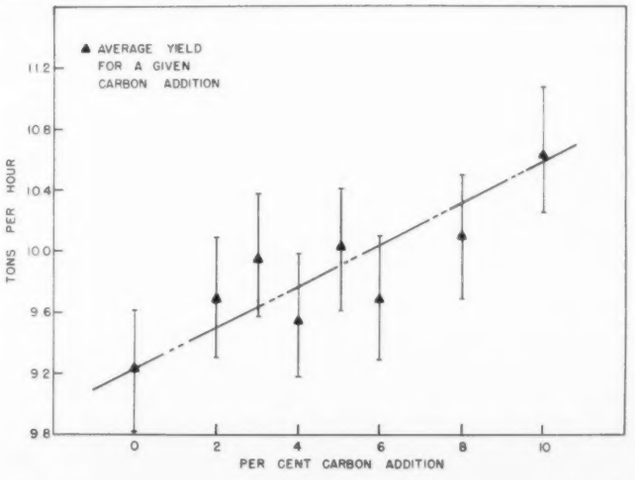


TABLE II
Summary of Carbon Black in Fuel Oil Tests

Per cent carbon black addition

Series	C-T Time (Hr)	Tons made	T/H C-T	T/H C-T corrected	Series	C-T Time (Hr)	Tons made	T/H C-T	T/H C-T corrected	Series	C-T Time (Hr)	Tons made	T/H C-T	T/H C-T corrected
	0					2					3			
1	9.17	79.69	8.69	9.74	1	8.57	85.59	9.99	10.98	1	7.55	80.61	10.68	11.05
2	8.72	74.28	8.52	8.68	2	7.90	75.73	9.59	9.74	2	7.75	79.06	10.20	10.60
3	8.83	81.97	9.28	10.04	3	8.48	79.98	9.43	9.52	3	8.13	79.99	9.84	9.97
4	9.82	81.27	8.28	8.78	4	9.27	83.20	8.98	9.56	4	7.78	69.97	8.99	9.50
5	9.90	84.40	9.90	8.93	5	8.05	81.49	8.05	10.76	5	8.37	83.20	8.37	9.80
6	8.25	73.24	8.88	9.17	6	8.10	77.14	9.52	9.85	6	7.57	78.22	10.33	10.31
7	9.10	82.85	9.10	9.21	7	8.10	75.32	9.30	9.04	7	8.45	73.91	8.75	9.10
8	8.53	76.28	8.94	9.31	8	9.72	80.54	8.29	8.10	8	9.23	81.63	8.84	9.46
Avg	9.04	79.25	8.95	9.23	Avg	8.52	79.87	9.14	9.69	Avg	8.10	78.32	9.50	9.97
	4					5					6			
1	8.05	76.68	9.53	11.25	1	7.58	78.27	10.33	10.30	1	8.05	74.95	9.31	9.01
2	7.63	78.35	10.27	10.16	2	7.65	80.46	10.52	11.73	2	7.62	76.76	10.07	10.74
3	8.00	81.89	10.24	10.49	3	8.00	78.43	9.80	9.95	3	7.95	80.34	10.11	9.97
4	8.47	75.93	8.96	9.75	4	8.33	77.05	9.25	9.83	4	7.87	75.52	9.60	9.58
5	7.80	76.45	7.80	9.72	5	7.90	79.92	7.90	9.46	5	7.67	72.66	7.67	9.79
6	7.33	65.87	8.99	8.93	6	7.43	77.81	10.47	11.03	6	7.80	82.47	10.57	10.94
7	8.62	78.37	9.09	8.75	7	8.63	84.55	9.80	10.01	7	9.23	78.57	8.51	8.75
8	11.30	87.64	7.76	7.60	8	9.38	69.08	7.36	7.81	8	9.35	80.50	8.61	8.80
Avg	8.40	77.65	9.08	9.58	Avg	8.11	78.20	9.43	10.04	Avg	8.19	77.72	9.31	9.70
	8					10					Average			
1	7.50	80.88	10.78	11.41	1	7.58	81.31	10.73	12.16	1	8.01	79.75	10.00	10.74
2	8.05	84.53	10.50	11.67	2	7.78	75.50	9.70	11.54	2	7.89	78.08	9.92	10.61
3	8.37	78.90	9.43	10.52	3	8.13	79.84	9.82	10.41	3	8.24	80.17	9.74	10.11
4	8.85	83.90	9.48	10.72	4	7.83	84.70	10.82	11.16	4	8.53	78.94	9.30	9.86
5	8.33	77.29	8.33	9.48	5	7.85	78.13	7.85	10.15	5	8.23	79.19	8.23	9.78
6	7.67	71.56	9.33	9.71	6	7.33	77.17	10.53	10.50	6	7.69	75.44	9.83	10.06
7	8.45	72.45	8.57	9.44	7	7.58	74.32	9.80	10.19	7	8.52	77.54	9.12	9.31
8	9.62	76.62	7.96	7.83	8	8.93	78.67	8.81	9.19	8	9.51	78.87	8.32	8.51
Avg	8.36	78.27	9.30	10.10	Avg	7.88	78.71	9.76	10.66	Avg	8.33	78.50	9.31	9.87

Summary

Carbon Black Addition, Per Cent	0	2	3	4	5	6	8	10
Average tons per hour	9.23	9.69	9.97	9.58	10.04	9.70	10.10	10.66
Average per cent increase	..	4.98	8.02	3.79	8.78	5.09	9.43	15.49

Productivity improved about 1.5 per cent for each per cent carbon added. At this time, it cannot be answered whether this improvement continues for more than ten per cent carbon addition. It would be reasonable to expect that the possible benefits do have an upper limit.

It is noteworthy that an all oil flame gave greater improvement than the part gas, part oil flame. This is contrary to expectations since, normally a gas flame is less luminous than an oil flame. Therefore, the carbon black when used with the combination fuel should produce greater improvements in emissivity, with a corresponding increase in productivity. This peculiarity may be due to turbulence. The gas, entering at high velocity, may produce more intense mixing of fuel and air than is possible with the all oil flame. This would result in the carbon particles burning more quickly, with a corresponding loss of their effectiveness as radiators before they can travel an appreciable distance in the furnace hearth area.

Since a complete review of the tests is quite cumbersome, an appendix is included with this report for those interested in details. This includes a summary of individual tests (Table II), a viscosity curve for the concentrate (Figure 12), and an explanation of the "Schmidt" method for measuring flame temperature and emissivity.

Flame radiation measurements on the open hearth furnace showed no significant effect of carbon addition on flame temperature or emissivity. This seems odd since the production improvements can hardly be explained by anything except greater emissivity. Due to the atmospheric conditions in the furnace while producing, acceptable readings could not be obtained. Therefore, the radiation readings had to be made on an empty furnace in which flame and wall temperatures are much different from those of a charged hearth. Temperature is known to affect both flame length and emissivity from a cloud of particles and may thus explain the anomaly.

As far as future developments are concerned, several questions were raised during this work which yet remain unanswered.

In the flame, the carbon particles seem to be of value only as long as they maintain their size at high temperatures. Yet it can be shown that the hot carbon will burn rapidly as soon as it comes in contact with oxygen. The less turbulent the flame, the longer the particle will stay within the flame envelope and away from oxygen. It seems likely that improved burner

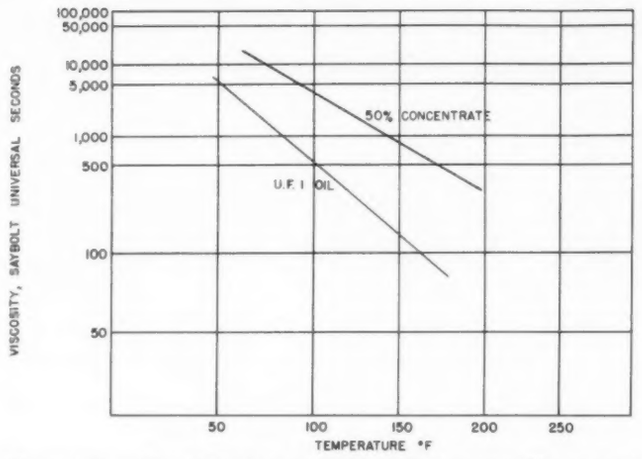


Figure 12 — Viscosity-temperature relations for 50 per cent carbon suspension and for light oil.

design, or a change in particle size could yield improved results, particularly for the 50 per cent oil, 50 per cent natural gas flame. One might ask why finely divided materials other than carbon would not work equally well. One may think of flour, bentonite, or other materials. Most of these substances have the disadvantage of high cost. In addition, if they fail to burn completely, damaging deposits may form in the checkers or flues.

The long term effects of carbon addition on checkers and brick work remain to be studied. There appeared to be no damaging effect on refractories. The tests indicated that checker deposits may be somewhat greater; however, it is estimated that checker blowing equipment could satisfactorily alleviate this problem. The deposits formed during the tests appeared to be much softer than usual and could be scraped from the bricks with very little effort. Chemical analyses did not show any significant difference between the usual deposit and that remaining after a campaign using carbon black.

On the basis of the tests conducted on the open hearth furnace, it can be concluded that:

1. The addition of carbon black significantly improved furnace productivity.

2. This improvement amounts to about 1.5 per cent for each per cent of carbon added up to at least ten per cent by weight of carbon.

3. While these results are for a 50 per cent oil and 50 per cent natural gas flame, a somewhat greater improvement was observed with an all oil flame.

4. Carbon black, when properly selected, can be suspended in fuel oil. A 50 per cent by weight concentrate is completely stable and pumpable.

5. The effectiveness of this process, with further study, is likely to be increased by the selective use of carbon addition, revised burner design, and other improvements.

Present data show that an increase in carbon addition will give a proportional increase in output. Such a relationship obviously cannot hold indefinitely. It will be of great importance to know what is the greatest improvement that can be obtained and at what level of carbon the best economics are achieved. It was hoped that flame radiation readings might prove a partial answer, but they did not for reasons discussed earlier. It is believed that accurate readings could be obtained by creating a furnace heat load, such as water-cooled tubes laid over a hearth, and using the methods followed in these tests.

It is believed that high emissivity throughout the furnace is particularly useful during charging and melt-down, but of minor importance during the refining period. These tests seem to confirm this. If this is true, it is then economical to vary the amount of concentrate to be added during a heat.

It is felt that the benefits to be derived from the addition of carbon to fuel oil in an open hearth are very worthwhile. However, the results of these tests primarily indicate that this is but a beginning with many unknowns yet to be discovered and explored. In the near future, it is hoped to continue the investigation to achieve and apply a more expanded knowledge.

APPENDIX

THE "SCHMIDT" METHOD FOR MEASURING FLAME TEMPERATURE AND EMISSIVITY

The radiation from a flame or combustion gas is measured by a total radiation pyrometer when the background is a high temperature wall and a "cold" surface. Two additional measurements are required, they being the radiation from the hot and cold surfaces without a radiating gas present.

When the flame is backed with a "cold" background, the radiometer indicates:

$$R_1 = Ae_F T_F^4 + a(1 - e_F)e_c T_c^4 \quad (1)$$

and with a hot background, the radiometer will indicate:

$$R_2 = ae_F T_F^4 + a(1 - e_F)e_w T_w^4 \quad (2)$$

The radiation from the cold background alone can be expressed as:

$$R_3 = ae_c T_c^4 \quad (3)$$

and from the hot background alone:

$$R_4 = ae_w T_w^4 \quad (4)$$

The previous four equations may be combined, including an instrument calibrating factor, K, to give the flame temperature T_F, equation (5), and flame emissivity e_F, equation (6).

$$T_F = K\left(\frac{R_1R_4 - R_2R_3}{R_1 + R_4 - R_2 - R_3}\right)^{1/4} \quad (5)$$

$$e_F = \frac{R_1 - R_2 + R_4 - R_3}{R_4 - R_3} \quad (6)$$

a = Stefan Boltzman constant—(0.171×10^{-8}) Btu per hr ft^2 °R^4
T_F = Average flame temperature—°R
T_w = Hot background surface temperature—°R
T_c = Cold background surface temperature—°R
e_w = Total emissivity of hot wall
e_c = Total emissivity of cold wall
e_F = Average total emissivity of flame
K = Instrument calibration constant—(1.361×10^3) °R/(mv)$^{1/4}$
R_1 = Radiometer reading (mv)—flame and cold background
R_2 = Radiometer reading (mv)—flame and hot background
R_3 = Radiometer reading (mv)—cold background
R_4 = Radiometer reading (mv)—hot background

Measurements were made with a radiometer using an indicating millivolt recorder as the sensing device. The radiometer was calibrated by simultaneously sighting it and a disappearing filament pyrometer on the backwall of the test furnace. This was done several times as the furnace brickwork cooled. The instrument was found to follow the relationship,

$$T = 1361 \times R^{1/4}$$

where T = temperature (°R) and R = radiometer output (mv). No consistent shift of the exponent was noted over the temperature range (2000–2700 F) used for calibration.

The figures of Table II show some of the data collected. Figure 12 is a viscosity curve of the concentrate of 50 per cent by weight carbon. ▲

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Trends In Ingot Buggy Design

. . . . future thinking in ingot buggy design will undoubtedly consider control by static devices to amplify and regulate signals and power; and by logic functions which will detect and arrange operational sequences . . . . basic features such as ropes, skids, inclines and simple weights will undoubtedly be retained . . . .

IN a batch process where the product is moved from point to point and manufactured step by step, each movement in the process must necessarily wait for its predecessor. The shaping of the steel starts in this manner. It is a pour, carry, cool, load heat, unload procedure; and there are periods of time in the process when the quality of the product, or even the continuance of the process itself, depends on an interval of the shortest possible duration between successive steps. Such an interval is initiated when an ingot is withdrawn from a soaking pit; and, for purpose of this paper, ends when the ingot is dropped on a blooming or slabbing mill table. More precisely, the period starts when an ingot is placed on an ingot buggy and lasts until it is discharged onto a mill approach table.

The need for speed is more than a mere try for high output. A huge block of steel at an elevated temperature is not only a difficult mass to contain and carry; but if the heat loss is excessive, the quality of the product is affected; and if the heat loss continues, a breakdown in the manufacturing process can be caused. The weight of the steel ingot at this point of the process will vary from 3 to 50 tons. Its temperature will be about 2000 F. The transport time from the soaking pit, where the steel is in ingot shape, through the slabbing or blooming mill, where it will have been worked on by mill rolls to a semi-finished condition, will be about two minutes. The total temperature drop will be about 200 F. Hence, time taken by transportation is necessarily minimized by every conceivable means. Every conceivable means can be summed up very tersely; reduce distance and move quickly.

Distance or length of travel is probably the most fixed factor in ingot buggy design. As the mill is laid out, so must it operate; for the two elements connected by the ingot buggy, soaking pits and rolling mills, are not in any sense portable. Much can be done, though, to minimize distance in the basic layout. The soaking pit must of necessity be located close to a stripper building and adjacent to the mill. The pits can be arranged on one or on both sides of the buggy or the delivery tracks. Too often, though, freedom of choice is not possible in locating the terminal points of the product flow; and frequently the growth of facilities imposes difficult location demands. The open hearth shops, cooling stations and just plain real estate can seriously influence the product flow and materials handling problem. About 500 feet is the maximum distance the ingot buggy is usually expected to travel; though, single line pits can double that distance.

There are some fundamentals involved in this layout problem. The soaking pit hearth area for a given mill capacity is a very real quantity. One tries to size the soaking pits to keep the mill supplied with hot ingots. Hence, a pit arrangement which permits a minimum of hot metal travel is highly desirable. But simply, sufficient space must be taken by the pits to meet the mill capacity. Whether it be a single or a multi-track ingot buggy layout, heating capacity of the pits is the criteria. Moreover, the flexibility accruing to arrangements for feeding more than one mill from a single set of pits is a consideration which frequently establishes first, pit arrangement, and secondly, ingot buggy travel.

The nature of the route of travel is not without its peculiarities which affect track wear and maintenance. The discharge point of the ingot buggy is fixed. The buggy may approach this point from either direction, as in the case where the mill approach table is at a right angle to the ingot buggy direction of movement; or the buggy may discharge at one end of its travel as in the case where the mill approach table is a continuation of the ingot buggy track. The pickup point is likewise fixed; although, it may be at any of the various pits from which the buggy will deliver ingots. Since the ingot buggy travel will vary as the different pits are unloaded, distance of travel will vary for both loaded and unloaded trips.

The course being fixed, there remains then, the possibility of toying with time. The limitations in shortening time are as positive as those imposed by distance; but because there are combinations of equipments having different time capabilities, the

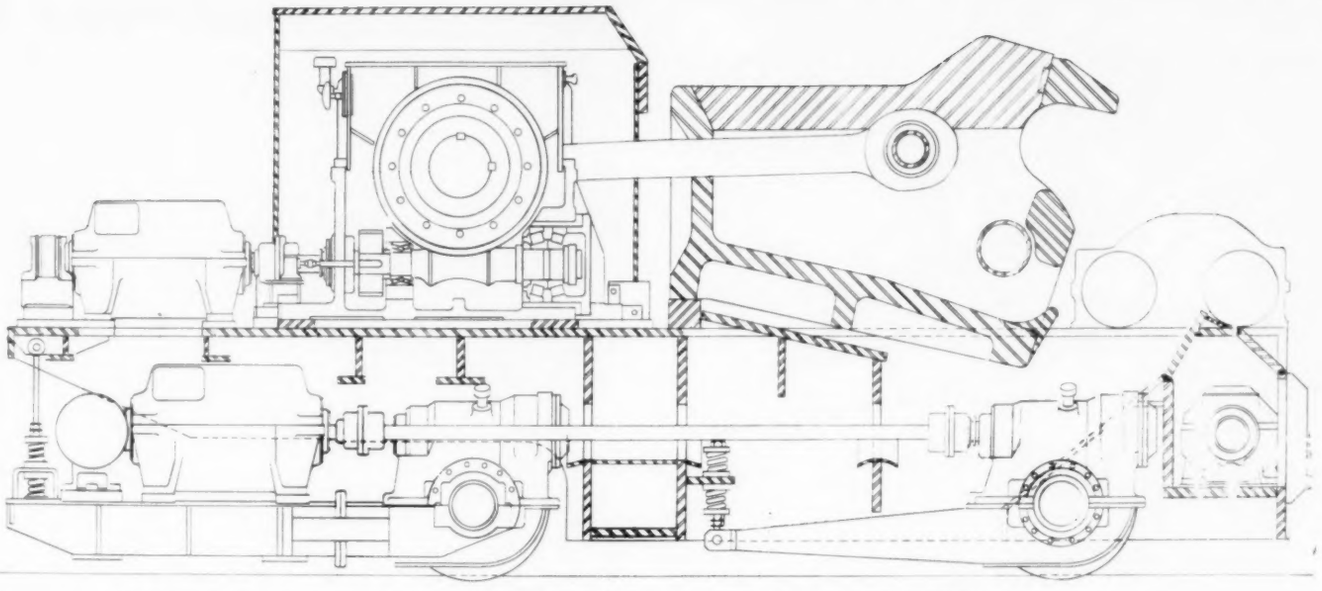


Figure 1 — This typical ingot buggy is designed to handle an ingot weighing up to 70,000 lb.

time of travel can be designed for almost any speed that economics and sound engineering will permit. Although seldom used, speeds up to 1200 fpm have been attained. Let us examine the apparatus presently in use.

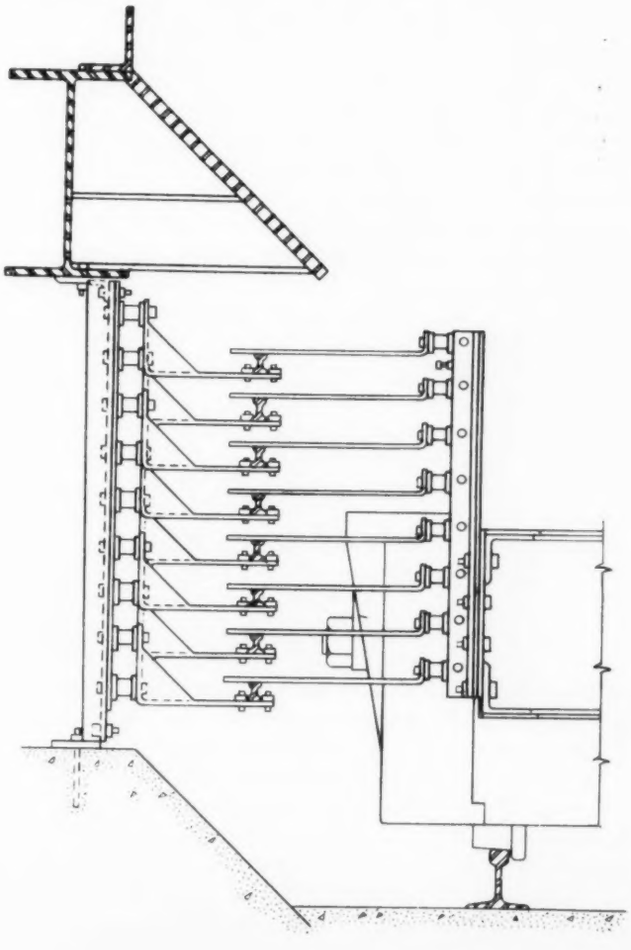
The buggy itself, like most steel mill equipment, is generally a monster of a machine. It has to be, not only to carry its load but to withstand the searing heat the load will transfer to its carrier. It usually rides on a 175-lb track. It can have up to four different drives; namely, for the longitudinal travel, tilting motion of the ingot pot, table rolls and operation of a pusher arm. Figure 1 shows a typical buggy. This machine weighs 268,000 lb, has a track spread of 10 ft, a maximum height of 12 ft, and is over 27 ft long. It is designed to handle an ingot weighing 70,000 lb. It is powered by two 100-hp traverse motors, one 75-hp tilt motor and one 35-hp roll motor. Power is supplied through six long collector rails for the traverse motors and ten short collector rails for the tilt and roll motors.

Classed by method of drive, there are two broad categories of ingot buggies; self-driven and cable-driven. Self-driven buggies enjoyed a fairly tight monopoly until the last decade or so. This category would embrace the occasional diesel or steam-driven operations, as well as the more frequently used electric drive. There are a few of the former. Steam or diesel-driven buggies with an operator driving the train are occasionally used in emergencies. In some layouts an operator will ride the buggy to solve a traffic problem; although, interfering traffic is rare because of the priority given to hot metal movements. The electric drive, whether it be self or cable-driven, has no doubt an exclusive acceptance.

The self-driven ingot buggy can be identified by its power source. Almost always direct current and usually 250 volts or less, the power source can be either constant potential or variable voltage. The advantage of one over the other has been fairly well established. The constant potential has been more widely applied because of its lower first-cost and general suitability. Variable voltage, however, offers the better control scheme in that acceleration and deceleration can be carefully controlled and contactors as a maintenance item are largely eliminated.

The self-driven buggy is burdened with the difficulty of obtaining its self-drive. Whether it be variable voltage or constant potential, the collector rails needed

Figure 2 — Collector rail arrangements are major design considerations.



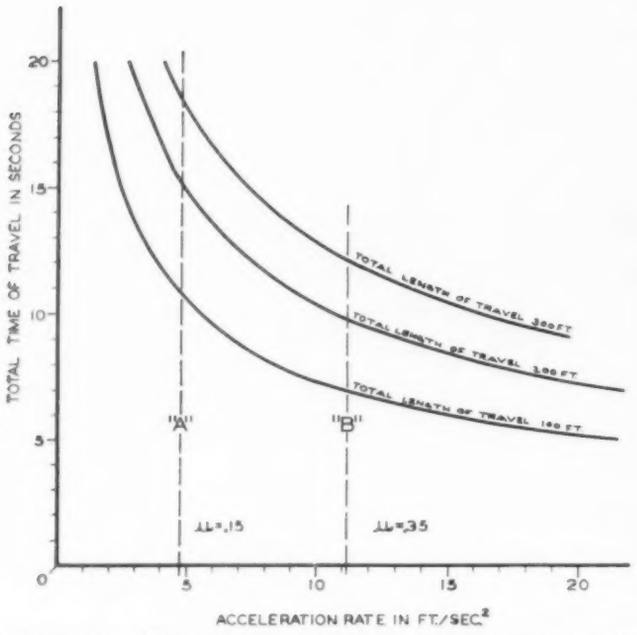


Figure 3 — Chart shows ingot buggy acceleration rate versus time of travel.

for transmission of power and control are difficult to maintain and are subject to severe abuse. Despite ingenious physical arrangements which protect the rails from falling ingots, loose scale, dust accumulation and other abusive treatment, the collector rails require constant attention.

Figure 2 shows a typical collector rail arrangement. Suitable spacing of the rails, adequate insulation, sufficient creepage distance are major design considerations. The mast and the sliding contacts have been built below the car or above, depending on where the designer thought it was safest. Yet, good design to the contrary, the most careful alignment and meticulous adjustments frequently fail when the buggy rides over a rail which has been flattened where an ingot has slipped from the tongs or fallen from a car.

An interesting modification of the collector rail is a flexible trolley wire which is reportedly in use on an ingot buggy drive in the British Isles. In this application a single wire is used as a power conductor. It is mounted in a trench at the side of the buggy track, the return being through the grounded track rails. Using a single wire requires that control components be mounted on the buggy. The advantage attributed to this arrangement is a reduction in damage to the collector system caused by ingots dropping or by track irregularities.

The major limitation to the self-driven buggy is acceleration. As can be seen from the curve in Figure 3, the mathematics of which is given in Appendix I, the coefficient of adhesion imposes a very definite limit to the change of speed rate. The coefficient of adhesion will vary from 0.35 for fairly clean track to about 0.15 for the more normal operating conditions. Graphite dust and scale are the largest contributors to a reduction in the coefficient of adhesion. This factor and the limitations that mounting space on the buggy imposes on horsepower makes the development of the ingot buggy beyond point "A" improbable; beyond point "B," impossible. Since acceleration of the driving wheels determines the capabilities of the self-

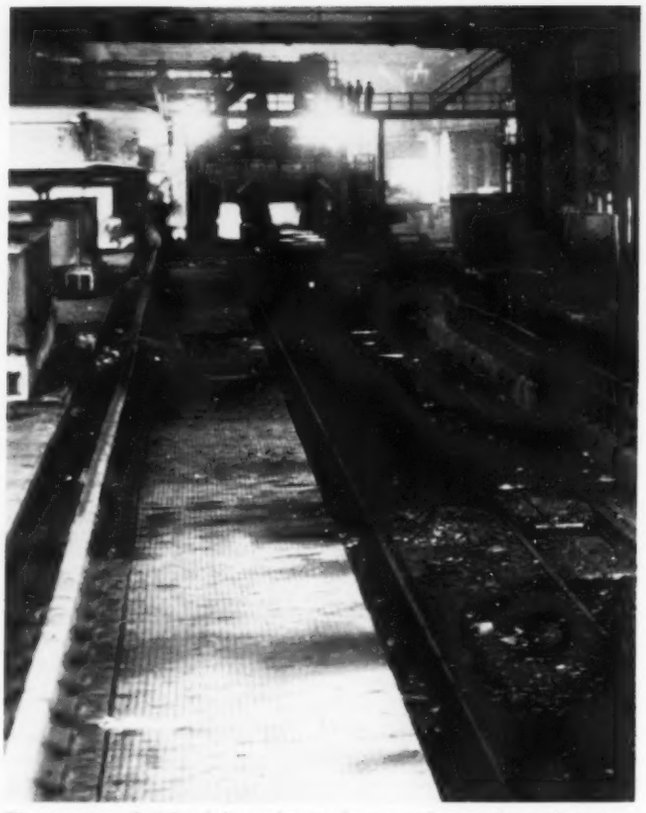
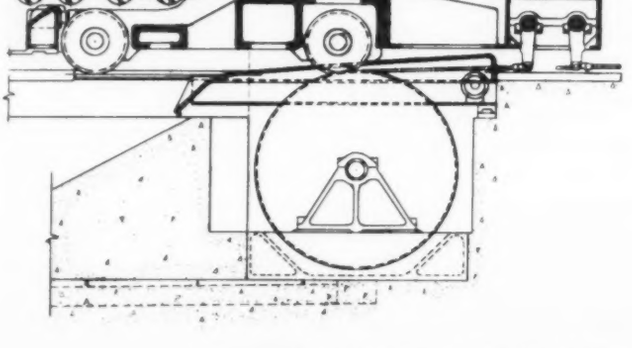


Figure 4 — Cable-driven ingot buggy shown here has top speed of 1000 fpm.

driven car, what would be the possibilities if the driving wheels were eliminated? The cable-driven car will permit such operation and, hence, acquires a school of acceptance.

There are two types of cable-driven cars; the single-drum drive and the two-drum drive. The single-drum drive uses a continuous cable looped back to a centrally located driving motor and the two-drum drive uses a motor at either end of the track. If the cable itself is a hazard, the two-drum drive reduces the exposure by about one half. Protection of the cable and the mechanism of tension and training are the biggest difficulties of the single-drum drive. But the single-drum drive offers a fairly easy solution to cable tension with the advantage of using about one half the electrical equip-

Figure 5 — This cable-driven buggy has an end discharge.



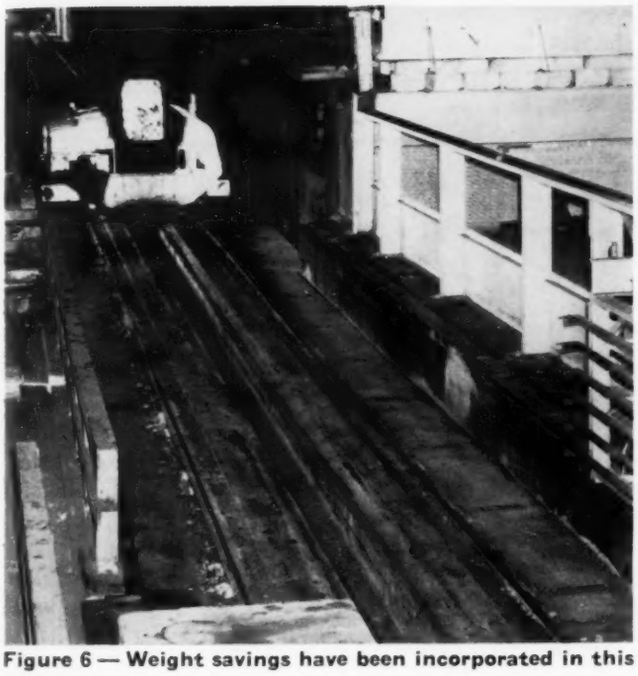


Figure 6 — Weight savings have been incorporated in this design.

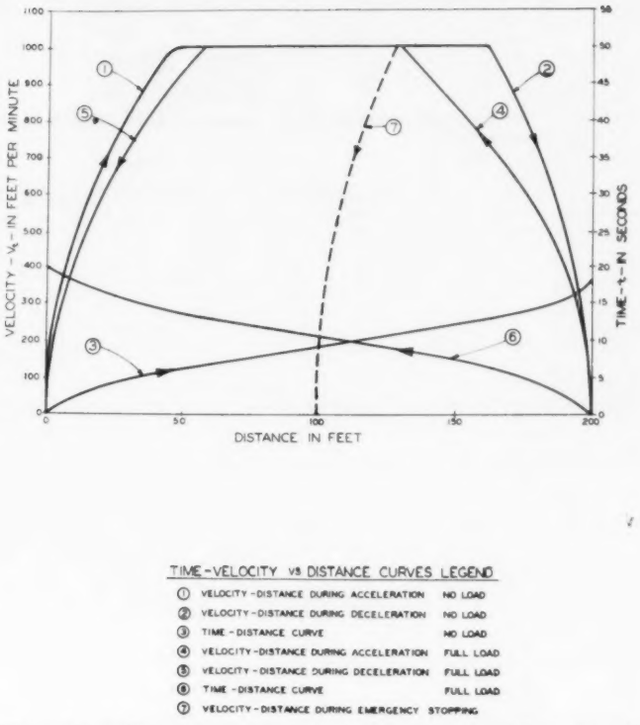

VELOCITY - V_c - IN FEET PER MINUTE
TIME - t - IN SECONDS
DISTANCE IN FEET
TIME-VELOCITY vs DISTANCE CURVES LEGEND
① VELOCITY-DISTANCE DURING ACCELERATION NO LOAD
② VELOCITY-DISTANCE DURING DECELERATION NO LOAD
③ TIME-DISTANCE CURVE NO LOAD
④ VELOCITY-DISTANCE DURING ACCELERATION FULL LOAD
⑤ VELOCITY-DISTANCE DURING DECELERATION FULL LOAD
⑥ TIME-DISTANCE CURVE FULL LOAD
⑦ VELOCITY-DISTANCE DURING EMERGENCY STOPPING

Figure 7 — Operating characteristics of cable-driven ingot buggy.

ment required for the two-drum drive. On the two-drum drive the cable usage is decreased by the elimination of double-backing the cable; and tension is achieved electrically by the trailing motor acting as a braking generator.

The cable-driven buggy operates almost entirely without a collector rail system. Except for components which are mounted on the buggy and which may require energy at some specific section of track, the cable-driven buggy can be powered and controlled without the problems posed by extensive collector rails. Either constant potential or variable voltage may be used, but the ability of the variable voltage system to regulate torque and thereby control acceleration and deceleration makes its combination with the cable-driving motors almost a natural. Since the driving motors are stationary, they may be solidly connected to the circuitry rather than through collector rails and they may be mounted in pits at the end of the buggy run, or in suitable shelters under or near the buggy tracks. The drive motors may be sized for acceleration and heat dissipation using forced ventilation to obtain the most economical frame size. As motor weight is not a limitation, ample horsepower can be made available. Cleaned air can be furnished and motor maintenance accordingly reduced.

There are some benefits to be gained for the control schemes too. The location of the car can be established by intelligence taken from the cable drum rather than by track limit switches or insulated collector rail sections. In utilizing the drum, the car position can be determined by means of a rheostat, a traveling nut limit switch or by a selsyn mounted on the drum and connected to operate a rheostat in a motor room or in a location having better protection than the ingot buggy motor pit. Further, the elimination of sliding contacts which might change component calibrations permits circuit refinements not previously possible. But the wider latitude given the electrical aspects must be considered in balance with the mechanical requirements.

Of prime importance is the cable. Its limitations are a consideration but are not necessarily formidable. Rigorous inspection can minimize operating failures, although the cables seldom wear out. A life of six to nine months is about average and usually is determined by the discovery of a frayed section portending a break. Figure 4 shows a cable-drive track arrangement. The cable tension on this installation varies from 4000 to 19,000 lb for a 1-in. diam rope, the higher loadings appearing as might be expected during acceleration and deceleration. The 1-in. rope uses a 10-ft diam drum and has 21 wraps for a car run of about 650 ft. The top speed is 1000 fpm. The buggy weighs 265,000 lb and is capable of carrying a 35,000-lb ingot. This installation is powered by two 200-hp, 800-rpm motors through a gear train of 24.7:1. Figure 5 shows the general arrangement of the buggy. It is a tilting pot buggy which discharges its load on tables placed at the end of the track. Tilting motion is imparted to the pot by the forward motion of the car as it enters the dock.

Another buggy with a different cable and carrier arrangement is shown in Figure 6. This is a somewhat newer design and points up the trend to lighter cars. The buggy weighs only 120,000 lb and can carry a 52,000-lb ingot at a top speed of 1000 fpm. It is pulled over a 500-ft track by a $1\frac{1}{4}$-in. cable wrapped on 6-ft diam drums. Power is furnished by two 150-hp motors through 15 to 1 ratio gear trains. This installation uses a 12-in. depression between the tracks as a cable slot. The car is equipped with scrapers which push dropped scale along the slot to a hole. The ingot is carried on table rolls and is discharged from the car end. The five table rolls on the buggy are driven by a 35-hp motor which is energized through short sections of collector rails.

The operating characteristics of this buggy are

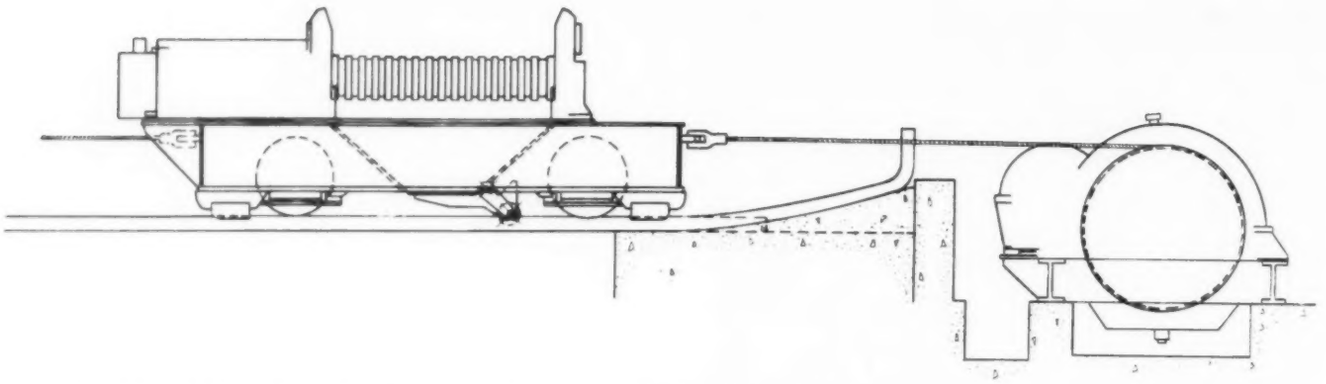


Figure 8 — This side-discharge buggy uses an incline as a final emergency stop.

shown in Figure 7. It can be seen that a 200-ft one-way trip can be made in about 20 sec. The accelerating rate for the loaded car is about 2 fps squared. It attains full speed in 8.5 sec over a distance of about 70 ft. The complete design data for this machine are given in Appendix II. It adequately illustrates what can be accomplished with this type drive.

Cable breakage is probably the greatest risk in this design. One needs no imagination to appreciate that cable breakage can have fearful results, especially if it happens on a loaded trip. But protective measures can be taken. Two things should stop: the drum and the buggy. On the double-drum drive the information that the cable is broken can be quickly obtained by load or current balance circuits in the control scheme or by a differential selsyn circuit. On the single-drum drive a limit switch responsive to cable tension can furnish the necessary signal; but stopping the drum will not assure stoppage of the car.

Considering only the time it is under tension, the odds probably favor breakage of the pulling cable, in which event the trailing cable should stop the car. But the inborn perversity of ingot buggies precludes reliance on such co-operation even when all precautions have been taken to physically protect the cable from dropped ingots and scale. Loss of tension in either of the two cables attached to the car could set brakes on the buggy. The brakes could be energized by air which could be compressed while the buggy is in the discharge dock, the compressor being powered through short sections of collector rails. Even a gravity or spring-loaded device might be triggered to slow down or stop the car. But since the damage that a free running car might cause can be confined to the ends of the track, given ample space, the stopping device might also be placed in this area. Thus, we can apply bumpers, retarders, or inclines to stop the car, and at worst, localize damage. If the car discharges at the end of the track, the emergency stopping cannot allow even localized damage.

An ingot buggy using an incline as a final emergency stop is shown in Figure 8. The incline is about ten ft long. The skids riding the incline will raise one end of the car about 2 ft. This buggy, which is about 20 ft long weighing 197,000 lb and carrying a 40,000-lb ingot, can be stopped from a maximum speed of 700 fpm within the length of the incline.

A particularly difficult problem, more aggravated on the cable-driven than the self-driven car, is track cleanliness. Normal scale droppage can be a source of serious interference with the training of the cable. Rollers have been used to support the cables, but scale accumulations very soon make these inoperative. Moreover, the rollers, unless properly recessed, interfere with any scraping or drag type cleaning device attached to the buggy proper. Since scale droppage is normal and cannot always be restricted to within buggy body, any cable layout should include a means for easy removal of scale from the track. Just how this may be accomplished depends a great deal on physical arrangements. The need for a foundation structure able to withstand the impact of a dropped ingot precludes the use of anything less than a solid track base. So the problem often reduces itself to containing the droppings to a hopper on the buggy for discharge at some specified point and the balance to a floor scraping, a hand shoveling operation.

Thus, does the ingot buggy continue its evolution. In the fluid state of steel mill engineering it is difficult to predict progress or future trends. Perhaps the last one built represents the latest thinking; or the idiosyncrasies of a particular designer; or only the solution to a peculiar problem. Like many other devices in a steel mill, it has evolved by the adaptation and application of many different advancements. Equipments change, new products are made available; and someone tries them on the ingot buggy. No doubt every mechanical and electrical innovation used throughout the industry will get its chance to qualify. It is evidence of a maturing evolution that a primitive way of moving objects like pulling them with a rope is revamped to become a steel cable coiled by extremely responsive machines and controlled by static devices, which amplify and regulate signals and power, and by logic functions, which detect and arrange operational sequences. While these things no doubt have a future with the ingot buggy; so, most certainly, do such basic implements as ropes, skids, inclines and simple weights.

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APPENDIX I

Calculations For Self-Driven Ingot Buggy Acceleration Rate

Symbols
V_2 = maximum velocity in feet per second
S_t = total distance of travel in feet
t_t = total time of travel in seconds
a = acceleration rate in feet per second, per second
F = force in pounds
w = weight in pounds
m = mass in pounds absolute
g = acceleration due to gravity in feet per second, per second
u = coefficient of adhesion

The travel time of an ingot buggy comprises acceleration time (t_1), running time (t_2), and deceleration time (t_3).
Total travel time;

$$t_t = t_1 + t_2 + t_3$$

Distance traveled during acceleration equals (S_1); at constant running speed, (S_2); and during deceleration, (S_3).
Total distance,

$$S_t = S_1 + S_2 + S_3$$

The distance traveled during acceleration equals ($^1/_2\ at^2$), thus:

$$S_t = \tfrac{1}{2}\ at_1^2 + S_2 + \tfrac{1}{2}\ at_3^2$$

If acceleration time equals deceleration time, then:

$$S_t = at_1^2 + S_2$$

and the distance (S_2) traveled at constant velocity equals (V_2t_2). Since $V_2 = at_1$

$$S_t = at_1\ (t_1 + t_2)$$

To minimize motor heating an optimum ratio of 25 per cent accelerating time to total oneway trip time is assumed. This results in 50 per cent running time and 25 per cent deceleration time.
Hence:

$$S_t = 0.1875\ at_t^2$$

or:

$$a = \frac{5.34\ S_t}{t_t^2}$$ as shown in Figure 3.

A factor in accelerating a traction drive is the coefficient of adhesion U, shown as follows:

$$F = ma$$

Since:

$$F = uw \quad \text{and} \quad m = \frac{w}{g}$$

$$uw = \frac{wa}{g}$$

$\therefore a = ug$
for u = 0.15, a = 4.82 fps² (Line A, Figure 3)
for u = 0.35, a = 11.2 fps² (Line B, Figure 3)

APPENDIX II

Design Data for a Cable Driven Ingot Buggy

Drive Motor MCSA 618	150 hp, 460 rpm at 230 volts Continuous rating 300 hp, 800 rpm at 400 volts forced ventilation
Ingot buggy	Net weight 120,000 lb Top speed 100 fpm at 400 volts Coefficient of friction 0.01
Ingot	Maximum weight 52,000 lb
Cable drum	6-ft pitch diameter
Motor to drum	Gear ratio 15.1 to 1; or nearest standard ratio
Gear efficiency	93 per cent
Cable data	$1^1/_4$-in. diam @ 2.5 lb per ft, 64.5 tons breaking strength

WR^2 of load components referred to motor shaft:

	Per unit lb-ft²	Total assembly lb-ft²
Motor armature	370	740
Motor brake	190	380
Motor coupling	50	100
Gearing	50	100
Drum coupling	10	20
Cable drum	210	420
Cable	74	148
Ingot buggy	4740	4740
Total unloaded		6648
Ingot		2160
Total loaded		8808

		Unloaded	Loaded
Equivalent weight acting at pitch diameter of cable drum	lb	143,000	222,000
Back pull at unwinding cable produced by 20 per cent torque at unwinding motor	lb	1,900	1,900
Motor load	amp	110	110
Friction load of buggy	lb	1,200	1,720
Propulsion at uniform speed (1000 fpm):			
Motor torque required	lb-ft	663	774
Per cent full load torque		37.7	44
Motor load	amp	210	240
Horsepower equivalent	hp	55	62
Acceleration to 1000 fpm:			
Maximum torque produced by pulling motor equivalent to 200 per cent full load torque	lb-ft	3,520	3,520
Motor load	amp	1,110	1,110
Net available torque for acceleration	lb-ft	2,857	2,746
Net available pull on cable	lb	13,350	12,850
Rate of acceleration	fps²	3.01	1.96
Time to reach full speed	sec	5.53	8.5
Distance traveled	ft	46	70.8
Stopping with motor only			
Pull at winding cable produced by 20 per cent torque at winding motor	lb	1,650	1,650
Maximum torque produced by retarding motor, equivalent to 200 per cent full load torque	lb-ft	3,520	3,520
Equivalent pull on cable	lb	16,450	16,450
Net retarding force	lb	16,000	16,520
Rate of deceleration	fps²	3.6	2.4
Time to stop	sec	4.64	6.94
Stopping distance	ft	38.6	57.8
Emergency stopping			
Retarding motor torque	lb-ft	3,520	3,520
Brake torque	lb-ft	3,600	3,600
Equivalent pull on cable	lb	33,300	33,300
Net retarding force	lb	32,950	33,470
Rate of deceleration	fps²	7.42	4.86
Time to stop	sec	2.25	3.42
Stopping distance	ft	18.7	28.5

Discussion

PRESENTED BY

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H. G. FROSTICK, General Supervisor, Design Engineering (New Mills Construction) South Works, United States Steel Corp., Chicago, Ill.

I. N. Tull: Mr. Frostick's topic is very timely, as there have been and are in prospect a number of mills requiring either brand new or revamped means of delivering ingots from soaking pits to rolling mills.

As he points out, time savings are very important, as temperature drop can cause a tremendous increase in the power required to roll the product or can cause

metallurgical difficulties of serious proportions. But speed of the conveyance is by no means the sole answer to proper delivery of the ingot to the rolls, as proper sequencing and timing of drawing and rolling enter into the requirements. There is a similarity to scale car and skip speed relationship at the blast furnaces, where mistakenly high skip speed is demanded, only to be wasted because of bell and distribution operations. Usually the skip car has to wait for scale car delivery, and that loss cannot as a rule be made up with excessive skip speed.

When high ingot buggy speed *is* a must, it is a very difficult job to get high acceleration and deceleration rates with traction type drives, and it is particularly in those applications that the cable-hauled buggy shows to the best advantage.

As the author points out, the multiplicity of collector bars and the difficulties of maintaining them are often the major running repair items encountered in service. Heat from the ingots and area warps the rails and causes insulator failure. On the other hand, ingots and scrap dropped on a hauling cable do enough damage to make cable repairs a large item of maintenance expense, as well as delay.

The single drum type of cable-hauled buggy requires counterweighting to keep slack out of the cable system, and while a reasonably satisfactory performance is obtained in that manner, the two drum arrangement is far superior, especially when the buggies are large and heavy. The two drum system functions much as the two coilers on a reversing strip mill, one drum pulling, the other holding tension, alternately.

Like other growths with increased production, the drums have grown from about 4 to the 10-ft diam mentioned by Mr. Frostick.

The subject has been well covered by Mr. Frostick, and as he says, "Equipment change, new products are made available, and someone tries them on the ingot buggy." Perhaps the computers will receive enough sorted information from steel men to come up with far superior means of transporting ingots from pits to rolls, but the computer's answer is dependent on correct information. Such information is accumulating through the media of papers such as this one, which presents proven facts from experience and points to future improvements with confidence.

A. R. Oltrogge: Whenever a speaker refers to the inborn perversity of ingot buggies, he automatically identifies himself as one who has had considerable experience with the subject. Our own experience would force us to agree pretty much with what Mr. Frostick has said.

The abstract of this paper, appearing in the September, 1957, issue of the Iron and Steel Engineer concludes, "Thus buggies tend to become lighter physically, and probably faster, and more complex electrically, though perhaps, more reliable." The reasons for these trends are perhaps obvious but it is interesting to note how Mr. Frostick's noted trend to lighter and faster buggies appears when fitted into an equation (Figure 9). In the upper left-hand corner we see the speed time curve for the buggy. Below the curve is the equation for the required RMS horsepower. This formula was developed by Stanley H. Williamson of our company. The formula is quite fundamental and

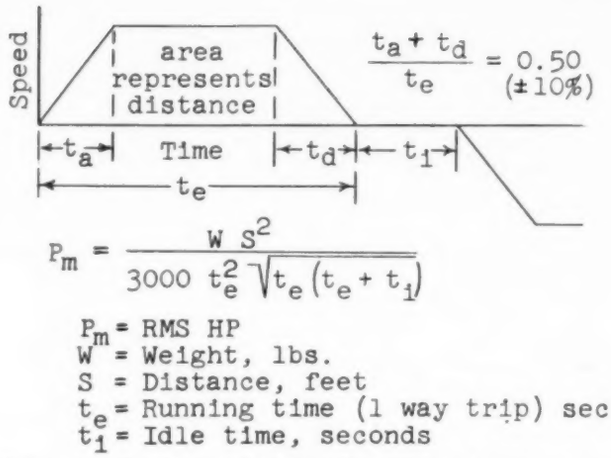
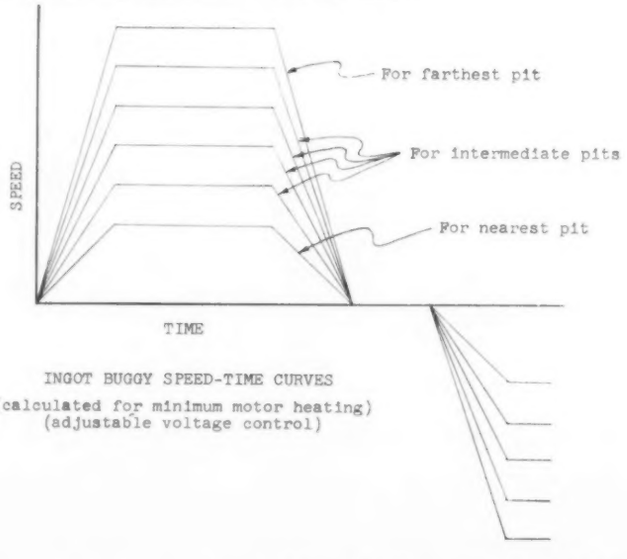


Figure 9 — Fundamental formula for ingot buggy computations.

therefore its basic form has broad usefulness. With the proportionality constant shown it applies to the typical self-driven buggy. First note that the relationship of accelerating and decelerating time pointed out by Mr. Frostick must be adhered to. The expression in the upper right-hand corner reminds us that accelerating time plus decelerating time divided by total time should equal approximately point five. Other assumptions, necessary for accurate results when using this formula, are first, that the inertia of the buggy referred to the motor shaft is large compared to the motor itself—in the order of 10 to 1; and second, that rolling friction forces approximate those encountered in standard railway practice and are small relative to the accelerating and decelerating forces. These assumptions are valid for the typical self-driven buggy.

Notice how horsepower increases directly with buggy weight. In the case of distance traveled, doubling the distance quadruples the horsepower. The effect of time can be better visualized if we momentarily assume that idle time is negligible. The denominator then becomes simply 3000 t_e^3. This says that in order to cut the time in half, the horsepower must be multiplied by 8. Obviously, after a buggy is built with a

Figure 10 — Curves are calculated for minimum motor heating with adjustable voltage control.



certain size motor, there is a definite limit to the possible reduction in cycle time. For this reason, the required cycle time should be figured or estimated conservatively.

With a slight change in proportionality constant, the equation fits single motor or single drum cable drawn buggies. With a greater change in proportionality constant it will apply to double drum cable drawn buggies.

Figure 10 shows something we have thought about (but never used so far) to reduce horsepower requirements (or saying it another way, motor heating). We are applying "rate-type" voltage regulators quite widely these days which makes it a simple matter to reduce the rate of acceleration for shorter trips. Motor heating for a short trip made at half speed and with half the normal accelerating rate would be ¼ that for the same trip made by simply reducing the full speed running time. Making short trips at half speed but with the same accelerating and decelerating rates cuts motor heating in half, but cutting the rate in half also reduces the heating by half again.

The above heating considerations, we believe, point up the superiority of the cable drawn design which offers the greatest possibility for a reduction in weight and can most easily cope with the substantial increase in horsepower requirements resulting from stepped-up performance, since the motors can be conveniently force ventilated as pointed out by the author.

The advantages of adjustable voltage control for high performance drives are generally well known. Not so well known is the fact that, other things (like armature current) being equal, the standard non-ventilated mill motor operating at double voltage (which most adjustable voltage systems provide) suffers increased heating due to increased friction, windage, and core loss. A high performance self-driven buggy with adjustable voltage control should have some provision for motor ventilation. D-c motor driven motor-mounted blowers have been applied but would appear to pose an additional maintenance problem. Motor mounted filters without blowers at least permit the shaft mounted motor fan to change the air in the motor while the latter is running if somebody remembers to change the filter once in a while. Certainly, the cable drawn buggy motor drive is in the best position to be force ventilated.

Another point in favor of the cable drawn buggy would seem to be that it minimizes the investment exposed to hot ingot bombardment, and to damage due to failure to stop at the appropriate time.

Along with the selsyn scheme mentioned by the author for cable break detection, we might point out that two tachometer voltages can be compared to monitor the system for cable breaks.

L. E. Ringger: Geneva Works rolling mills of the Columbia-Geneva Steel Division, United States Steel Corp., recently completed an ingot buggy installation which incorporates the latest design principles for cable-drawn ingot buggies as described in Mr. Frostick's paper. The new installation is a replacement of an earlier self-propelled type similar to the one shown in Figure 1 of Mr. Frostick's paper. When deciding on the new ingot buggy system, consideration was given to the maintenance and operating problems encountered with the self-propelled type. An addition of soaking-pit furnaces had extended the length of ingot buggy travel. This additional length of travel and possible future extension of travel made very necessary an ingot buggy with relatively high top speed and a low rate of maintenance outages. The original ingot buggy required 25 sec to accelerate to top speed of 660 fpm. After a comprehensive study of the cable-drawn and self-propelled type buggies and after careful review of new ingot buggy installations, it was decided that the cable-drawn buggy would best suit our operating requirements.

The cable-drawn buggy eliminated the troublesome collector rails required by the old traction drive. A collector system was still required by the roll drive on the buggy, but this was a short system at the table end only and could be easily maintained. The use of two cable drives, instead of one drive and a cable loop, allowed for easier cable installation and replacement, and cable stretch adjustment. Also, it was felt that the cable tensions could be controlled much easier by two drives. The drive systems for the two cable drums could be located away from the track and mill tables in a clear and easily accessible area.

The self-propelled type buggy had to be heavy in order to provide friction for reasonable acceleration and deceleration of the buggy. The cable-drawn buggy presented us with an opportunity to reduce its weight to a minimum, this reduction being limited only by the minimum strength required for this type of operation. The new buggy was designed for a maximum empty weight of only 120,000 lb. This reduction in weight presented an opportunity for increased acceleration and deceleration values which resulted in a reduction in time required per operating cycle. The moving mechanical equipment required on the buggy could be minimized for the required wheel axles and a table-drive system. The wheels and axles could be properly dimensioned to provide an increased safety factor for shock loading of ingots on the buggy.

The type of ingot carrying and delivery apparatus on the buggy was carefully considered. The tilting-pot type carriage was not considered due to mechanical and electrical complications inherent with this type of design. The flat ingot buggy table with a self-contained drive possessed the most straightforward answer to this problem.

Positioning control could be readily obtained because of the continuous and accurate location of the buggy relative to each driving drum which would result in accurate control of buggy location by the operator.

In our ingot buggy installation, we felt we could overcome the problems encountered by previous cable-drawn buggies through improved design. The cable is normally a source of trouble due to dropped ingots cutting or severely burning it. We designed a trench in which the cable would be protected from dropped ingots. A scraper and wire brush was attached to the buggy, cleanout holes were provided in the trench and the accumulation of scale and slag was pushed by the buggy through these cleanout holes. The trench was heavily reinforced to prevent damage which would distort the trench and cause damage to the scraper.

Another anticipated problem was a runaway buggy

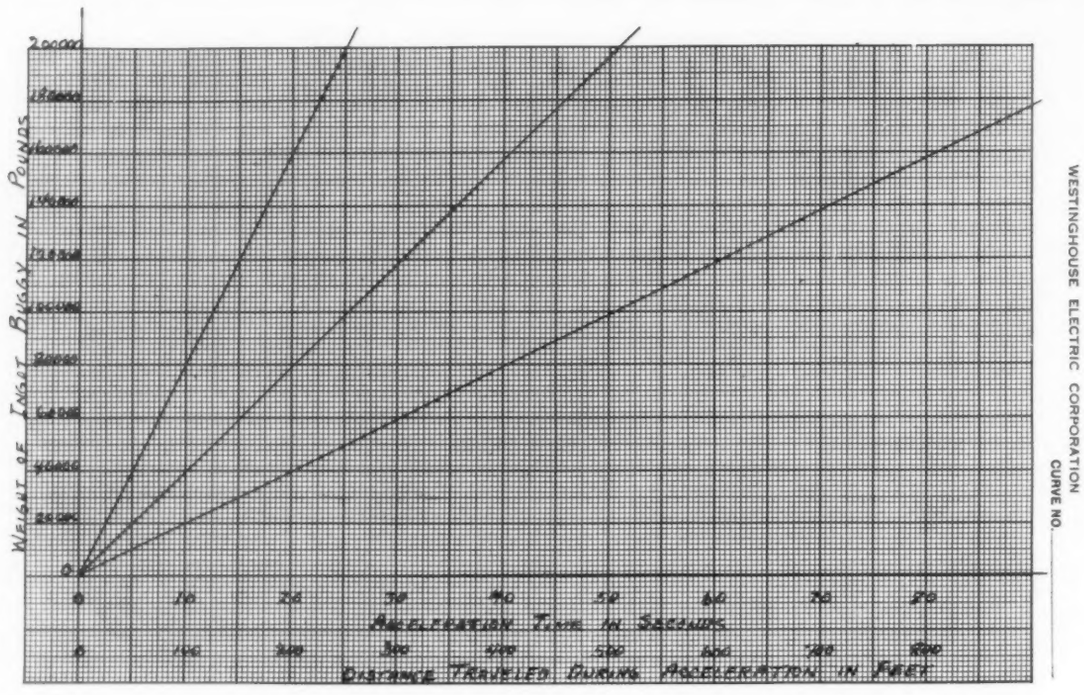


Figure 11 — Acceleration time and travel during acceleration are proportional to the weight.

due to a broken cable. Electrical control protection (slack cable) was provided for most breakages of cable. The breakage of the trailing cable during operation was the only condition for which electrical protection could not be provided. In our design we incorporated four hydraulic buffers, two located at each end, to contact the buggy and apply a hydraulic cushion for emergency stopping. Calculations showed these buffers would stop a fully-loaded buggy without damage to the buggy, tables or buffers. Tests during operation proved this to be correct.

Calculations were made for our proposed cable-drawn buggy using a theoretical buggy weight and a time sequencing schedule was set up. It was found the buggy could maintain mill production running from any pit position operating at only 600 fpm top speed. Since this buggy was designed to operate at 1000 fpm, provision was made for future additions of soaking-pit furnaces.

The five-roll-buggy table allows placing the largest ingot completely on the buggy. The rolls and scale hopper are so arranged as to allow all scale to be contained in the buggy until it is carried to the table-end scale bin. Through the use of this flat-bed roll table, the pit cranes can always place the ingots with the desired end toward the mill, eliminating the use of our ingot turn-around equipment.

The electrical system makes extensive use of magnetic amplifiers for the necessary tension and voltage regulators which are equipped with adjustable rate-of-change control features. The ingot buggy power supply consists of one generator feeding both drum-drive motors through two booster generators, one each connected in series with the drum-drive motors. A second generator which was used in parallel with the other generator for the old ingot buggy system, was provided with the necessary switching arrangement so it can now be used as a standby generator.

J. Raymond Erbe: As pointed out in the paper, ingot buggies have been built with many arrangements and types of drive; however, we believe it can be safely stated that the ideal has not yet been reached.

Since all further processing of the steel is dependent upon the ingot buggy delivering the ingot from the soaking pit to the blooming mill, it must be a dependable drive. Because of the weight of present ingots, their temperature, the probability of their being dropped by the pit crane, and other such factors, there has been a tendency to build still heavier ingot buggies. Some of these have exceeded 250,000 lb. Even such behemoths have been unable to withstand having a 60,000 lb ingot dropped on them from a height of more than 6 or 8 in.

It is seen from Figure 11, that both the acceleration time and the distance the buggy travels during acceleration are directly proportional to its weight. Also it is seen that increasing the torque of the drive proportionally reduces the accelerating time and the distance traveled during acceleration. However, as pointed out by the author, there is a limit to which the torque can be increased on a self-propelled buggy because of wheel slippage due to several factors. The same is true of a cable-driven buggy, but to a lesser extent, since the maximum stress allowed in the cable is the limiting factor rather than the coefficient of friction between the wheels and the rail.

Consequently, we wonder if more consideration should not be given to designing lighter ingot buggies; which can be considered expendable, if you wish, as they will only be strong enough to transport the heaviest ingot. Such a buggy can be accelerated and decelerated faster and in a much shorter distance. Furthermore, such a buggy would not constitute as great a hazard to equipment if it became uncontrollable resulting in a collision. Two or possibly three such buggies could be built for the cost of one of the present behemoths and in the event one buggy became damaged it could readily be lifted from its track by the pit crane and replaced by one of the spares. Such a buggy would reduce the problems of the control engineer.

H. G. Frostick: You just cannot generalize on ingot buggies because as soon as you do someone will come up with one that proves your conclusion is wrong. ▲

WESTINGHOUSE ELECTRIC CORPORATION

Importance of Pumpability and Heat Stability in industrial greases

. . . . viscosity of oil is principal determining factor in pumpability of grease at low temperatures . . . .

by Wm. A. Magie, 2nd
Vice President
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IT has been felt for a long time that good pumpability and heat stability are the most important requirements of any industrial grease. Pumpability means ease of application down to 10 F. Heat stability on the other hand does not necessarily mean a high melting point. Users are interested in the actual body of a petroleum grease under shear at 130, 150, 180, and 200 F which are the temperatures frequently encountered. The author feels an extremely high flow point on a grease under static conditions determined in accordance with the ASTM drop point test is really not important. Attention is called to paragraph 2 of this particular ASTM test because it is significant: "the ASTM Dropping Point is the temperature at which the grease passes from a semi-solid to a liquid state under the conditions of the test. It should not be considered as having any bearing upon service performance." Users are therefore interested in examining the changes in body that occur in different type greases between 10 and 200 F when the grease is under the shearing action found in actual service.

Let us establish the points where a grease is recommended in preference to an oil and what is the basic requirements of this grease. *First*, we need a grease for all points that are remote or hard to reach and, therefore, can expect only occasional attention. However, the modern centralized lubrication systems now in use by most steel mills have done much to lubricate these points at regular intervals and in the correct amount. *Second*, grease is desirable for bearings that are intermittent in operation where the lubricant must adhere to the parts and be ready for immediate use—in this case, oil is not as satisfactory because it is drained off during shutdown periods except where the bearing can be sufficiently immersed. *Third*, a solid lubricant is used where it must act as a seal against dirt and water and at the same time stay in the bearings. It seems to us that these three extremely important uses for grease have emphasized one basic requirement—a fairly uniform body under all anticipated temperatures and varying rates of shear.

If the semi-solid lubricant does not have such uniformity and stability, it has failed in its job and the grease manufacturer has lost the confidence of both the machinery designer and the lubricating engineer in industry. These are the men who will determine whether there will be more oil-lubricated bearings in the future—or discover a larger potential for the proper grease which can do the job better.

Thus a good grease must lubricate at all temperatures and withstand all conditions of shear for the purpose to which it is put, much the same as a very high viscosity index, well refined oil of the multi-grade type satisfies its particular sphere. This grease must contain oxidation inhibitors for high temperature operation as do oils, used under the same conditions. A grease in most cases cannot be much better than the oil from which it is made. If the usefulness of an inhibited petroleum lubrication oil is limited to approximately 200 F under constant use, why do we stress the importance of a 375 or 500 F ASTM drop point grease? The oil contained therein ceases to function properly at temperatures far below these points.

Observation gained from actual field experience indicates that a temperature of 175 F is realistic for

petroleum products and something up to 235 F can be tolerated. This is based on data gathered over a period of years and is a composite of many tests run at one large industrial plant. It is presented here to indicate in a very general way, the thermal stability of the oils from which petroleum grease is made.

The economics is against using synthetics except where small quantities are involved. For purpose of illustration it might be stated that there is a particular plant where the packing on a temperature control instrument is lubricated at installation only and this instrument will fail to operate when the packing binds. At a 250 F ambient temperature, a petroleum grease lasted six months requiring dismantling and rebuilding of the unit. A silicone grease went for about two years on the same application. In this case, a pound or two of the silicone type grease will cover the requirements and, therefore, prove most practical.

To further clarify this thinking, the maximum temperature at which we can realistically expect *constant* operation, looks like 130 to 150 F for calcium and aluminum grease. It is believed that inhibited high melting point grease such as barium, lithium or sodium are limited to 180 F for a five-year life expectancy and to six months life expectancy at 250 F. For example, at one shop where seven electric motors at 750 rpm speed having a 170 F rise with an ambient temperature of 110 F or a total maximum of 280 F ran about six months or 4000 hours on a sodium soap grease, 6000 hours on a silicone grease and 7000 hours on a copper pthalocyanine silicone grease at $26 per lb. No lubricant so far has run 8500 hours, which would coincide with the yearly shutdown period. It is not as easy to determine the limits of thermal stability on greases as on oils due to the complex structures involved. The type of soap and fat used in the solid lubricant in addition to the oil base makes the variables extremely great.

The ASTM penetrometer is used for determination of static consistencies at 30, 77, 150 and 200 F temperatures. These are called gel strengths as expressed in tenths of a millimeter of penetration with the standard 150-gram assembly.

Both *low* and *high* temperature pumpability findings are established by use of a small centralized lubrication system pump connected to a copper coil immersed in a temperature controlled bath. These readings indicate what to expect of the lubricant *under shear* as opposed to the static gel strength. After considerable trial and error, a $^{3}/_{16}$-in. outside diameter copper coil, 25 feet long, was set for the *low* temperature recordings from 77 down to 0 F or to a maximum of 5000 psi on the gage, whichever came first. Readings are taken at every 10 degrees change in temperature going down as well as at the same points coming back up to room temperature. The grease remains at each recording temperature for a soaking period of ten minutes before reporting it. For *high* temperature work, the same $^{3}/_{16}$-in. outside diameter copper coil is used, but in this case it is 100 feet long. This additional length is necessary in order to develop enough back pressure to get comparative readings and reproducible results at the high temperature range. The reported findings are adjusted to compensate for the longer coil at high temperature. We report at 150 F on all the greases tested and at 200 F on all noncalcium greases. In both the low and high temperature tests results are expressed in pounds as recorded by a gage which is inserted in the line between the pump and coil. This reads the various pressures that are built up to overcome the flow resistance in the coil of each type of grease tested. These figures could also be expressed as pressure drop since the end of the tubing is open to atmosphere. The total pressure read on the gage at the entrance of the tubing is actually the pressure drop.

The following talks do not show all the temperatures at which the greases were tested because of space limitations. Note that upper line after each grease is

TABLE I

Grease viscosity of oil	Soap content, per cent	Drop point, F	Pumpability expressed in psi (upper line for each grease) gel strength or penetration expressed in tenths of mm (lower line for each grease) Temperature, F			
			30	77	150	200
Calcium A (450 @ 100)	11	200	1900	775	390	— psi
			265	325	360	— mm
Calcium B (125 @ 210)	9	205	5000	1100	350	— psi
			265	316	370	— mm

TABLE II

Grease viscosity of oil	Soap content, per cent	Drop point, F	Pumpability expressed in psi (upper line for each grease) gel strength or penetration expressed in tenths of mm (lower line for each grease) Temperature, F			
			30	77	150	200
Calcium A (450 @ 100)	11	200	1900	775	390	— psi
			265	325	360	— mm
Sodium (300 @ 100)	11	312	2150	500	119	63 psi
			273	306	324	372 mm

TABLE III

Grease viscosity of oil	Soap content, per cent	Drop point, F	Pumpability expressed in psi (upper line for each grease) gel strength or penetration expressed in tenths of mm (lower line for each grease) Temperature, F			
			30	77	150	200
Lithium A (450 @ 100)	8	360	2200	770	275	106 psi
			280	320	333	342 mm
Sodium (300 @ 100)	11	312	2150	500	119	63 psi
			273	306	324	372 mm

TABLE IV

Grease viscosity of oil	Soap content, per cent	Drop point, F	Pumpability expressed in psi (upper line for each] grease) gel strength or penetration expressed in tenths of mm (lower line for each grease) Temperature, F			
			30	77	150	200
Lithium A (450 @ 100)	8	360	2200	770	275	106 psi
			280	320	333	342 mm
Lithium B (300 @ 100)	11	358	2450	975	465	290 psi
			265	325	344	352 mm

back pressure in psi, and lower line is penetration in tenths of a millimeter. Table I compares two calcium greases by showing the pumpability test which represents shearing action with the gel strength which is static. Calcium A has a light (450 @ 100) and Calcium B has a heavy (125 @ 210) oil. At 30 F, room temperature, and 150 F, the penetration or gel stengths are about equal. From this one might expect equal pumpability at all temperatures but very wide differences are found below room temperature—5000 psi on the gage at 30 F for the heavy oil and only 1900 for the light oil grease. Yet at 150 F the lighter oil grease showed a higher gage pressure or tighter gel than the heavy oil grease. The reason for this is probably due to the higher soap content—2 per cent—and a consequently heavier body at the elevated temperature. Oil viscosity, however, seems to govern the low temperature flow characteristics of a grease.

Table II compares the pumpability recordings with the gel strengths or penetrations, and include the drop point. The present study is for calcium and sodium base greases of like body and approximate oil viscosity. The penetrations at 77 F are 325 for the calcium and 306 for the sodium. Note that the ASTM drop point of 312 F in the case of the sodium grease will not indicate its consistency under shearing action in the pumpability recordings. With a drop point of 312 F the sodium grease shows a pressure of 119 psi at 150 F while the calcium grease with a drop point of only 200 F maintains a pressure of 390 psi at the same 150 F temperature. Even at 180 F this same calcium base grease only dropped to 310 psi on the gage. Note the sodium grease at 150 F has more body than the calcium in terms of penetration, but not so when it was forced through the coils.

Table III compares the lithium A with the typical sodium ball and roller bearing grease. Here the static penetrations at 30, 77, 150 and 200 F on the lithium and sodium are quite close. However, in the pumpability data, there is a very different story. The lithium shows a pressure of 275 psi at 150 F against 119 for the sodium, while at 200 F, lithium reads 106 psi against the 63 for sodium. We do not like the weakening of the gel strength under shear at 150 F and 200 F on the sodium for open bearings, but in enclosed ball and roller bearings, where there is little danger from leakage, this can be an advantage in lubricating these rapidly moving parts.

Table IV compares two lithium greases with different soap percentages but with approximately the same viscosity oils. Both of these greases look very close in drop point and penetrations at the various temperatures reported. The increase in soap content from 8 to 11 per cent makes a great difference in the high temperature pumpability pressures. Although the static penetrations were about equal, the shearing action in the coil has changed the bodies considerably to give a much softer grease on the 8 per cent soap lithium. In the pumpability test at 200 F the pressure gage recorded 390 psi on the 11 per cent lithium soap grease while the 8 per cent lithium soap grease fell off to 106 psi at the same temperature.

Table V again compares the gel strengths in terms of the ASTM penetration with pumpability tests at low and high temperatures. This time it is on lithium

TABLE V

Grease viscosity of oil	Soap content, per cent	Drop point, F	Pumpability expressed in psi (upper line for each grease) gel strength or penetration expressed in tenths of mm (lower line for each grease) Temperature, F			
			30	77	150	200
Lithium B (300 @ 100)	11	358	2450	975	465	290 psi
			265	325	344	352 mm
Barium (300 @ 100)	10	364	2400	850	437	350 psi
			264	316	339	361 mm
Bentone (300 @ 100)	8		1000	450	90	50 psi
			255	310	328	363 mm

TABLE VI

Grease viscosity of oil	Soap content, per cent	Drop point, F	Pumpability expressed in psi (upper line for each grease) gel strength or penetration expressed in tenths of mm (lower line for each grease) Temperature, F			
			30	77	150	200
Aluminum A (450 @ 100)	10	210	1500	675	120	— psi
			265	320	396	— mm
Calcium A (450 @ 100)	11	200	1900	775	390	— psi
			265	325	360	— mm

TABLE VII

Grease viscosity of oil	Soap content, per cent	Drop point, F	Pumpability expressed in psi (upper line for each grease) gel strength or penetration expressed in tenths of mm (lower line for each grease) Temperature, F			
			30	77	150	200
Calcium A (450 @ 100)	11	200	1900	775	390	— psi
			265	325	360	— mm
Calcium C (450 @ 100)	16.6	239	1250	790	350	275 psi
			210	277	329	360 mm

TABLE VIII

Grease viscosity of oil	Soap content, per cent	Drop point, F	Pumpability expressed in psi (upper line for each grease) gel strength or penetration expressed in tenths of mm (lower line for each grease) Temperature, F			
			30	77	150	200
Calcium E.P. (115 @ 210)	9	200	5000	1100	250	— psi
			262	314	375	— mm
Lithium E.P. (115 @ 210)	9	380	5000	820	265	— psi
			185	321	335	— mm

B, barium and a bentone grease of like body and oil viscosity. There is not much difference in the penetrations of these three greases except to perhaps say the bentone is slightly harder at 77 F—310 penetration against 325 for the lithium. The pumpability characteristics on the lithium and barium grease are quite similar all the way through. It was found the bentone lost its body very rapidly under shear above room temperatures, along much the same pattern as the

sodium. However, the low temperature characteristics of the bentone grease were much superior to the sodium grease which we tested. The sodium grease reported showed a pressure at 77 F of 500 psi against the bentone grease of 450 psi—at room temperature they are about equal in pumpability, but at 30 F the bentone showed only 1000 psi against 2150 psi for the sodium, indicating much better low temperature handling of the bentone grease.

Table VI compares the pumpability and gel strengths of calcium grease A with an aluminum grease of the same oil viscosity. Here again the gel strengths are about equal and the low temperature pumpability readings are similar, but the calcium grease at 150 F maintains its body under shear very much better than the aluminum.

Table VII compares the gel strength and pumpability of calcium grease A with calcium grease C which is dehydrated and has a 239 F drop point. Unfortunately this is a No. 2 NLGI grease in the dehydrated calcium against a No. 1 consistency in the calcium A. In this case, this particular grease was available and therefore used. Pumpability at low temperatures on the heavier grease is even better—this is shown for the purpose of again bringing out the feeling that soap content is not the determining factor under frigid conditions. It is interesting to note that this experimental calcium grease has excellent heat stability even at the 150 and 200 F temperatures—350 and 275 psi respectively.

Table VIII compares the pumpability and gel strength of a calcium extreme pressure with lithium extreme pressure of like oil viscosity. The pumpability characteristics of both the calcium and lithium are about equal at low temperatures but at room temperature the calcium has a better body and at 150 F the calcium still holds 250 psi on the pressure gage against 265 psi for the lithium.

To accept any generalizations from the limited tests shown here may be unfair. However, after studying carefully the results of all similar work, some observations can be made, which may be helpful. The program confirms the belief that the viscosity of the oil is the principal determining factor in the pumpability of a grease at low temperatures. Given the same viscosity oil two greases with rather widely varying soap percentages in the tests shows much the same low temperature handling characteristics with the possible exception of bentone which is not a soap-base grease. However, a higher soap content (although both greases may have the same penetration at 77 F) gives a tighter gel at elevated temperatures.

The ASTM drop point does not indicate what to expect of a grease under shear at elevated temperatures. In comparing calcium versus all the high temperature greases, equal, and in some cases much better consistency, are found under shear on the calcium up to 150 F. Even up to 180 F the calcium grease was found to become less fluid in the pumpability test than all the others with the exception of the barium grease. The calcium showed 310 psi against 393 psi for the barium. At temperatures in the vicinity of 200 F, lithium and barium seem to give the same answers, while sodium and bentone show softer consistencies under shear. Bentone showed much less thickening under cold than any of the greases tested, but along with the sodium grease it lost its body faster under rising temperatures.

In conclusion the high temperature pumpability tests, where the grease is in a state of motion, or shear, has given much helpful information. The static penetrometer tests at elevated temperatures are similar to the ASTM drop point test and, therefore, the drop point cannot be taken as a criterion of the maximum temperature at which a grease can be recommended for use.

Discussion

PRESENTED BY

BEN HOLLIDAY, Chemist, Crucible Steel Co. of America, Midland, Pa.

WM. A. MAGIE, 2ND, Vice President, Magie Bros. Oil Co. Franklin Park, Ill.

A. E. CICHELLI, Lubrication Engineer, Construction Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa.

JOHN SIMON, Lubrication Engineer, National Works, National Tube Div., United States Steel Corp., McKeesport, Pa.

E. S. REYNOLDS, Senior Engineer, Socony Mobile Oil Co., Inc., New York, N. Y.

Ben Holliday: Although considerable progress has been made in the design and operation of centralized systems, the pumpability of the grease is still a major factor in satisfactory operation. Today it is not uncommon for greases to be pumped from 160 to 200 ft, being subjected to both hot and cold, as in blast furnace installation.

There are two questions I would like to present: First, in tables showing pumpability expressed in psi, why was 30 F used as the low temperature? It would be interesting to see what the pumpability of Calcium A, which showed 1900 psi at 30 F, would be at 0 F or even −10 F, since these temperatures are sometimes encountered. Also was pumpability measured at any definite volume, say two ounces per minute, and pressure recorded at various temperatures?

Second, is oil separation a problem when dealing with grease at elevated temperature and pressure? For example, will Calcium A with a 11 per cent soap content before being pumped at 150 F and 390 psi, have the same soap content at the system outlet or will soap be separated and cause a build-up on the inner walls of the tubing?

Wm. A. Magie, 2nd: We actually took our cold temperature readings at 10 and 20 F as well as at 30 F but we had to stop some place for purpose of projection. Maybe we would have been smarter had we gone from 77 right down to say, 10. But we did not do it, however. Calcium A at 10 F showed 4900 psi and at 20 F, 2800 psi. The rate of flow was approximately six grams a minute. It is a very small rate of flow.

Regarding the separation question of calcium after subjecting it to 150 and 180 F, on Calcium A, we did not. We are quite sure we did not because we cleaned

them out after each test, they cleaned out rather easily and we repeated again and obtained the same results in the same coils.

Now, on the question of finding any separation at the end of the tubing, I do not believe we found enough to be concerned about. I am not sure that you can find separation by this method, with you on any grease, but you could find it in other ways and we did in another test. We developed this in another paper we gave. We found it by putting a vacuum on the grease. We were able to pull the oil out of some greases much faster than others.

Incidentally going back to the pumpability tests there were some greases that we ran in those coils that were extremely hard to clean out, but we cannot say this was caused by separation of the soap from the grease—it was the nature of the grease at elevated temperature. That, to my way of thinking, is a pretty good indication of what you can expect, too, when these lines are next to hot metal.

A. E. Cichelli: Did you vary the rate of pumping at any time throughout your test work, and, if you did, how did it affect your results? Did the viscosity index and pour point have any bearing on the results you obtained? Finally, in view of the conclusions that you have drawn, which seem to be substantiated by your laboratory results, have you attempted to project your findings into field applications and, if so, did they correlate with your laboratory results?

Wm. A. Magie 2nd: On the first question, did we vary the rate of pumping? No, we did not vary the rate of pumping. I cannot remember that we ever found anything that was very astounding there in varying the rate—not in moving grease.

Did the viscosity index of the oil and the pour point of the oil change results? We used only 60 to 75 viscosity index oils. Most of that 300 and 450 material had a fairly good natural pour test, down around 10 below zero, some of them lower. We could not see too much difference there, because when you get the soap in you complicate the situation. We are currently experimenting with two oils having pour points 50 degrees apart and widely different VI indices.

The question on field experience is a good one. We think that in a very general way, we have proven it out, but have to say that we could not pinpoint every one of those tests to a known field experience. In a general way they correlate fairly well. This question came up and we did not find much difference in the throughput of the grease using a positive pump, although the pressure was varied.

John Simon: This interesting topic is of particular interest to me since at present we are working in the same field, that of pumpability but, apparently toward a different goal. While Mr. Magie has evaluated and compared soap against soap, high viscosity base oils against low viscosity at high and low temperatures; our objective will be to determine if a given grease will continue to function in our dispensing systems through a sharp temperature drop.

Current methods of laboratory evaluations of pumpability falls somewhat short of accurately predicting the behavior of the grease in the system under different temperature and pressure conditions. It is our plan to develop rate on, shear data in the field at diminishing temperatures, then attempt to duplicate the results with laboratory equipment, which will no doubt lead to the modification of our present testing device or to the development of a new one.

Although Mr. Magie combines heat stability and pumpability in the same paper, these two desirable features are usually difficult to find in one product. It is known that greases made with high viscosity oil results in a more stable high temperature product and as Mr. Magie points out, the high viscosity oil will result in poor low temperature pumpability. As a result the manufacturer must sacrifice one to enhance the other. Some better quality products are fortified with additives to improve both high temperature stability and pumpability.

E. S. Reynolds: The work of which John Simon spoke, is going to prove particularly interesting because in some experimental work it has been found that the shear rate of the greases going through metering valves and dispensing equipment may be very low, and the reactions which are caused by these small openings and very low flow rates have a great deal to do with the pumpability problems encountered particularly at low temperatures.

I would like to ask one question of the author: On what you give as static figures, I assume you mean the unworked penetration, and I wondered if you have done any comparable research using work-penetration to compare with the figures which you showed on the chart?

Wm. A. Magie 2nd: The static penetrations are strictly as you said unworked penetrations. We knew of no way to work these greases in the standard grease worker at elevated temperatures. What we wanted from our penetration tests was strictly an unworked grease at the elevated temperatures because this was similar to the ASTM drop point test—the grease was not under any stress or strain—it is just sitting there in heat. This test, of course, is opposed to our pumpability work at elevated temperatures when the grease was constantly under motion and shear. ▲

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Factors in the

THE power distribution requirements of a modern integrated steel plant are such that the design of the distribution system requires careful analysis. Many papers can be, and have been, written covering many phases of the problem. This paper will be confined to a general outline of the power requirements, discussion of some of the loads characteristics and plant conditions to be met, and discussion of a few of the factors to be considered in designing a system for a steel plant.

POWER REQUIREMENTS

In Figure 1 curve A shows the total power in kwhr per year generated in this country by all power sources including the power generated by industry for its own use. Curve B shows the power used in all industry. Curve C shows the power used in the steel industry including what is generated by the steel industry for its own use.

All curves show an accelerating rate of increase. The industrial power which was about 50 per cent of the total in 1939 has dropped to about 40 per cent in 1956. The share of industrial power used by the steel industry has stayed relatively constant at approximately 13 per cent.

Figure 2 shows the annual steel production in net tons of ingots, and the kwhr of power per ton of steel. The increase in kwhr per ton is due to several factors, among them being the retirement of steam drives, the increasing use of electric arc furnaces, and the increasing speeds of rolling and finishing operations.

The values of kwhr per ton shown are averages for the industry. Power requirements vary with the particular operation. Open hearths, for instance, require eight kwhr per ton of product, blooming mills 26, and strip mills 45 to 60. The total kwhr per ton of ingots can vary widely from plant to plant and within any one plant depending on operating conditions.

The power generated by the steel industry for its own use at present amounts to about 32 per cent of the power used. This percentage is dropping because the kwhr generated per ton are basically constant, while the kwhr used per ton are increasing.

Steel plants vary in size from less than 250,000 tons per year capacity to 5,000,000 tons or more. Loads will run from say 10,000 kw in a small plant to 150,000 kw in a large one. An average plant would have approximately a capacity of 1,250,000 tons per year and an average load of perhaps 40,000 kw. Such a plant will have in the neighborhood of 3000 to 4000 motors, varying from fractional horsepower ratings up to possibly 8000 or 10,000 hp per motor.

SYSTEM REQUIREMENTS

A—Physical distribution of loads—Steel mill loads are not uniformly distributed over the whole plant area. Rather they tend to group together in certain locations more or less apart from each other, leaving many areas with relatively light loads.

Electric furnace shops, blooming mills and strip mills are examples of local areas of the plant with relatively high loads. Strip mills in particular have a highly concentrated load. A typical medium width strip mill will have 100 major units consisting of motors, generators and transformers in a wide range of sizes at a number of different voltages. The total nameplate rating of the 100 units will be 100,000 kw and they will be located in a motor room 60 ft wide by 500 ft long. The average load may be roughly about 12,000 kw.

In addition to such heavy load locations there are extensive areas of relatively light loads such as yards and storage buildings, with lighting and crane loads of the order of 200 kw, as well as numerous small loads of 5 to 15 kw scattered over the entire plant area.

The distribution system must be designed to serve

Figure 1 — Although power usage by the steel industry has gone up, the portion generated at the plant has declined.

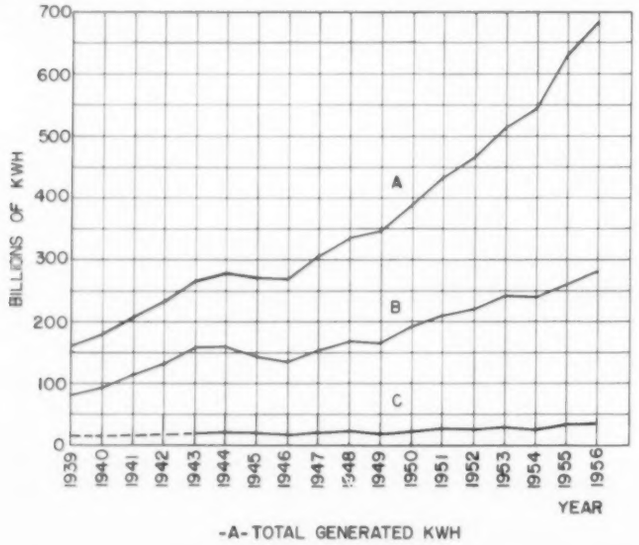
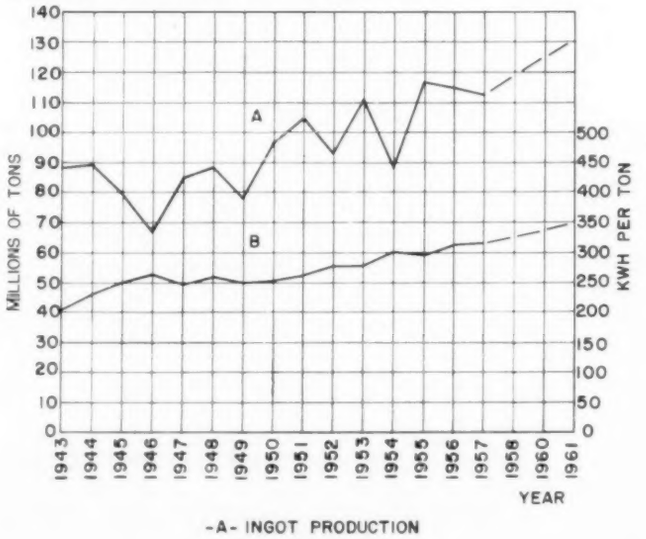


Figure 2 — There is a constant increase in the kwhr required per ton of steel production.



Design of A Steel Plant Power System

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. . . . this paper was presented at the 1958 AIEE Summer Meeting, Buffalo, N. Y., on June 25, 1958 . . . .

all loads, heavy or light, scattered or concentrated.

B—Use of d-c power—Considerable power is used in steel plants in the form of direct current. There are two reasons for this. First, to take advantage of the speed-torque characteristic of the series or compound wound motor to drive such equipment as cranes and mill tables, and second to obtain speed adjustment and control on main drives and processing equipment by the use of shunt-wound motors.

In the past motor-generator sets furnished most of the constant 250-volt power for cranes and mill auxiliaries, but mercury arc rectifiers are becoming increasingly popular. Most mill main drive d-c motors are supplied from their own motor-generator sets. In recent years a factory assembled packaged unit of motor-generator set or rectifier, d-c motor and variable voltage control has been applied to many smaller processing drives.

Approximately one half the motors (exclusive of motor-generator set drives) in a steel plant are d-c motors and the d-c power consumption in kwhr is usually about one half of the plant total.

C—Load characteristics—Steel plant loads vary widely in character from relatively steady loads to intermittent, widely fluctuating loads with high momentary values. A knowledge of the character of such loads and how they combine is essential in designing an effective distribution system.

Loads are usually described in terms of demand factor and load factor. Demand factor is defined as the ratio of short time (usually 15 min) demand to the total connected load nameplate capacity. Load factor is the ratio of average load to demand. Steel plant demand factors range from 0.1 to 2.5 and load factors from 0.1 to 0.85 depending on the particular motor or circuit.

Table I is a tabulation of various steel plant loads with their demand and load factors. The values shown should be considered as rough indicators only, as they may vary somewhat in different cases.

In the case of individual motors where the loads are intermittent and repetitive, the demand and the average load tend to become identical. The character of the load is better understood by using the maximum momentary load instead of demand.

A crane hoist motor which has a highly intermittent load is shown in item 1. A circuit feeding a number of cranes is shown in item 2. The demand factor of the circuit is low because of the diversity of the individual motor loads. Mill auxiliary motors are busier than crane motors and the circuits usually have higher demand and load factors.

The d-c generator output supplying a number of crane circuits is shown in item 3 and the d-c generator output supplying both crane and mill auxiliary circuits is shown in item 4.

A-c loads combine in a similar manner. Items 5 and 6 show two very dissimilar a-c motor loads. Such motor loads combine in an a-c circuit as shown in item 7. The output of an a-c transformer supplying a number of such circuits is shown in item 8.

This kind of information concerning the individual loads and the effect when combined makes it possible to properly size motor-generator sets, rectifiers and transformers.

* At time of paper presentation.

TABLE I
Examples of Steel Plant Loads

	Unit	Instantaneous peak, kw	Demand, kw	Average Load, kw	Connected Load, kw	Demand Factor	Load Factor
1	D-c crane motor	160		18	75	2.13	0.112
2	D-c feeder	175	98.6	70	515	0.191	0.71
3	D-c substation	1,370	600	400	8,050	0.074	0.333
4	D-c substation		490	230	2,500	0.196	0.71
5	440-V pump		520	410	900	0.578	0.788
6	440-V chipper	8.2		1.14	7.5	1.09	0.139
7	440-V feeder		570	375	560	1.02	0.658
8	440-V substation		1,500	970	1,700	0.882	0.646
9	Blooming mill	2,500		1,488	3,730	0.67	0.595
10	Strip mill		61,600	47,400	128,000	0.48	0.769
11	Electric furnace	14,050	11,400	6,960	10,000	1.14	0.66
12	Plant total		26,000	18,200	92,800	0.28	0.70
13	Plant total		101,500	75,600	353,000	0.288	0.745
14	Plant total	167,500	137,000	108,600	328,000	0.417	0.792

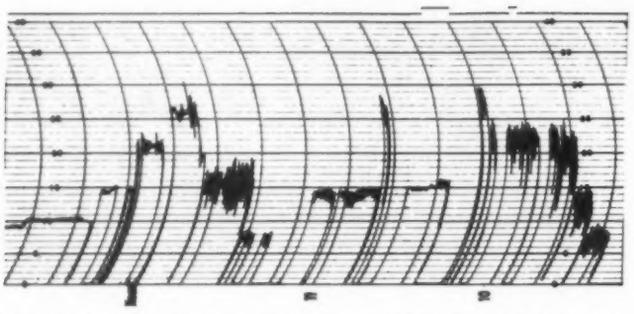


Figure 3 — Chart shows typical variation in load for electric furnace. Full scale equals 40,000 kw.

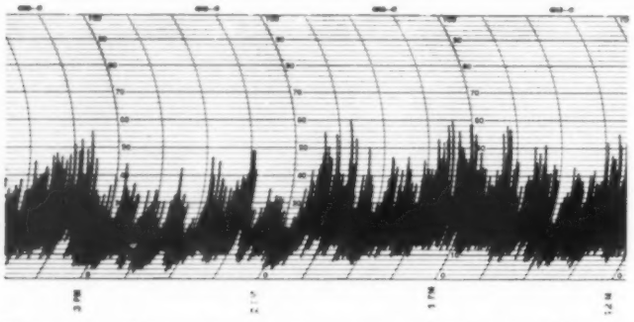


Figure 4 — Chart shows typical motor load on a 250 volt, d-c substation. Full scale equals 2000 kw.

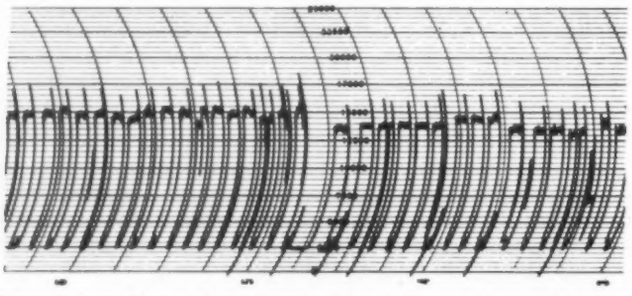


Figure 5 — Chart shows typical load for tandem cold strip mill. Full scale equals 25,000 kw.

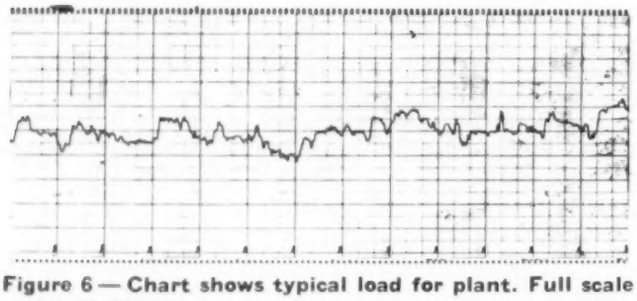


Figure 6 — Chart shows typical load for plant. Full scale equals 40,000 kw.

Individual mill main drive motor loads and the total loads of mills also have varying characteristics. A reversing blooming mill drive is shown in item 9. A typical hot and cold strip mill load is shown in item 10 and an electric furnace load is shown in item 11.

All these varying types of loads combine to form a total plant load with the characteristics as shown in items 12, 13 and 14 in the tabulation.

Figure 3 shows a typical electric furnace load.

Figure 4 shows the motor load on a 250-v d-c substation.

Figure 5 shows a typical tandem cold strip mill load.

Figure 6 shows a total plant load for a 12-hour period. It can be seen from Table I that the total loads of various plants have a degree of similarity. The diversity of the various individual loads has a tendency to level out the total load.

In a very general way, the demand factor tends to decrease as the number of individual loads and the total power increases, but there are many exceptions to this.

At first glance the relatively low demand factor shown for total plant loads would indicate that the plant is overpowered, but it must be remembered that the majority of motor drives, large and small, at some point in their load cycle are operating at or above their nameplate ratings. In fact, in many instances the designed short time rating of the motor is taken advantage of in determining the nominal hp. Strip mill main drive motors for instance may be operating at 150 to 175 per cent of rating while steel is in the mill.

There seems to be relatively little published data on steel mill load characteristics and a comprehensive paper on this subject would be a valuable addition to the technical literature.

D—Growth of loads—A well designed distribution system for a modern plant must make necessary provision for load growth.

Steel production has doubled since 1939. The total kwhr used have more than doubled. See Figure 1.

This growth has come about in four ways:

1. Additional complete new steel plants.
2. Additional facilities in existing plants.
3. Modernization and expansion of existing equipment.
4. Miscellaneous small additions to existing equipment.

The greater part of the increase in tonnage and power load has come about by the installation of additional facilities in existing plants and by modernization of existing equipment. Sometimes these two procedures are indistinguishable in a plant expansion program.

Load expansion from the addition of numerous smaller loads should not be overlooked. Steel plants do not stand still between major expansion programs. There are continual additions to equipment for various reasons.

Most plants have had the problem of putting increased loads on an existing power system which was limited in capacity. Some plants have been lucky in being able to expand their system without too much difficulty. Other plants have found themselves faced with the problem of expensive major changes in the system to meet the new situation.

Steel plant loads are growing at a continually increasing rate. For instance, a plant with a demand of 12,700 kw in 1935, and 19,400 kw in 1950 reached 30,000 kw in 1957. At that rate of growth it will have a demand of 50,000 kw by 1965. The accelerating rate of growth emphasizes the need for looking to the future in designing a power system.

Obviously, it is out of the question to install a complete system now to handle loads years in the future. Not only would the cost be exorbitant, but we would not know where to locate equipment, or what size or kind to use. However, proper planning now can make it possible to have a system which will lend itself to expansion in the future, with a minimum of cost and inconvenience.

E—Continuity of service—Steel plants put high value on continuity of service. Management and operators take a dim view of power outages, with consequent delay, loss of production, and the possibility of serious damage to major equipment.

This view is understandable when it is considered that the direct payroll cost is a larger proportion of production cost than is the case in many other industries. A power failure affecting the whole plant could cost an average size plant around $8000 an hour in payroll alone, without considering other things.

The main pump house is a critical point in a steel plant. Loss of cooling water for more than a few minutes can do thousands of dollars of damage, particularly at the blast furnace. Most plants have special provisions for keeping the pump house in operation on some kind of emergency basis in case of power failure.

F—Summary of system requirements—

1. Ability to supply all normal plant loads within their normal fluctuation limits without disturbance.
2. Flexibility for adjustment to future growth.
3. Maximum provision for personnel safety. This item has not been discussed in detail, but it is a major consideration in any power system.
4. Maximum provision for continuity of service.
5. Minimum cost commensurate with the previously stated requirements.

In all cases a balance must be struck between excessive cost of installation on one hand and operating difficulties and consequent expenses on the other hand.

OVER-ALL DESIGN

A—Circuit arrangements—Circuit arrangements in steel plants to carry power from the source to the multitude of individual loads take many forms, depending on a variety of conditions. Circuit arrangements are shown by means of single-line diagrams of some form.

Circuit arrangements fall into several basic forms. The simplest is the simple radial, where power is transformed to a single utilization voltage at one central point and distributed to the loads over radial feeders. The practical limit of power capacity is low, and it is little used by steel mills as a plant-wide distribution system.

Steel mills make extensive use of what is known as the load center principle. Power is distributed at high voltage to various load areas, at which points it is transformed and distributed locally in that area at utilization voltage. The low voltage distribution in the area is in turn distributed to motor control centers from which it is distributed to individual loads.

A modification of the simple radial is used where high tension power is distributed on radial feeders and transformed at the load center. In some cases the secondary circuits are connected by tie lines, normally open, in which case it is known as a secondary selective system. It permits taking transformers and high tension switchgear out of service, but becomes expensive with heavy loads if distances between load centers are great.

Primary selective systems are in use. In these there are two (or more) primary high tension feeders to each load center. Such systems provide more security than conventional radial systems, but require more breakers and are more expensive.

Primary loop systems are in use. Here the primary high tension feeder forms a loop, with the load centers tapped off through breakers arranged so that sections of the loop can be isolated. These systems require a less number of breakers than others, but must be adequately relayed to provide reasonable security. In some cases the security against failure is provided by making it a double loop, with primary selective breakers at the load centers.

Some plants have network systems, where the primary feeders or the secondary feeders are interconnected. In some cases there are both primary and secondary networks. Such systems have the advantages that transformers can operate in parallel, voltage regulation is good, there is maximum security against power failure provided the relaying is adequate, and almost any part of the system can be taken out of service. However, it is also the most expensive system, requiring more in lines and circuit breakers, and is complex in operation.

In many plants the power system is further complicated by the fact that in their early history they operated on 25-cycle power, and much of their present load is still 25-cycle. Often frequency changers are used to transfer power from one system to the other.

Many steel plants take advantage of the available by-product gas fuel to generate power. Few plants generate enough power for their own use, so there is the further complication of interconnection between their own generating plant and the power company system.

In some instances, groups of plants which generate their own power are tied together in a power system, and this system in turn has interconnections with one or more power companies. Such systems become extremely complex.

Figure 7 shows the high tension distribution system of a plant using a primary loop arrangement. At the time the diagram represents, the loop was not yet completely operative. This arrangement is at best advantage where load centers are large and distances between load centers are considerable.

Figure 8 represents what is basically a primary selective system. The principle of two feeders to each load center has been carried out consistently. This is a flexible system.

Figure 9 represents a network with extensive interconnections. It has the advantage and disadvantage already noted for such systems. In this particular case the relaying is very complete and the whole high tension system is operated by supervisory control.

Plant conditions vary in many ways, such as size, shape, power required, existing power system, etc., and no one circuit arrangement will fit even two plants. Each arrangement has a price tag and a service value. The best basic system to apply is the one that, after evaluation of all factors, best meets the requirements of the plant being considered.

B—Voltage levels—The choice of voltage to use in a steel plant is important on three points, the cost of equipment, the short-circuit values that can develop, and the flexibility for expansion. A number of excellent

papers dealing with this problem have been written and only some general comment will be made here.

A small plant, up to perhaps 20,000 kva, capacity may have a primary distribution voltage of 4160 v or possibly 2300 v, and a low voltage of 440 v, as well as 220 v, 110 v and 250 v d-c which are common to all plants.

A medium sized plant, up to possibly 150,000 kva capacity may have a primary distribution voltage of 6.9 kv, an intermediate voltage of 2300 v, and a low voltage of 440 v. In some cases the primary distribution voltage may be 11 or 13.8 kv, and the intermediate voltage may be 4160. In some cases where 6.9 kv is the primary distribution voltage, the intermediate voltage is omitted. If 6.9 kv is used in a plant approaching 150,000-kva capacity, the primary bus must be sectionalized to limit fault currents. A primary distribution voltage of 13.8 kv in this range of sizes is to be preferred.

In larger plants, of more than 150,000-kva capacity, a voltage of 23, 34.5 or 69 kv is used, exclusively as a distribution voltage, with the utilization voltages following the general pattern described.

A voltage of 6.9 kv or 13.8 kv is applicable to motors of 2000 hp and more. Unit substation capacity at these voltages is about 15,000 to 20,000 kva, and 2300 v is applicable to motors of 200 to 2000 hp from unit substations of about 5000 kva. The practical upper limit of motor size at 440 v is 500 hp and the usual size of unit substation is 1500 kva.

In determining the best voltage to apply, as in determining other phases of a power system, a number of inter-related and sometimes contradictory considerations must be evaluated.

C—Transmission Lines—Usually when the voltage has been determined the decision is also made whether to put the primary feeders overhead or underground. Both methods are in use in the steel industry, and have their advocates. Underground lines are not usually used on voltages over 15 kv.

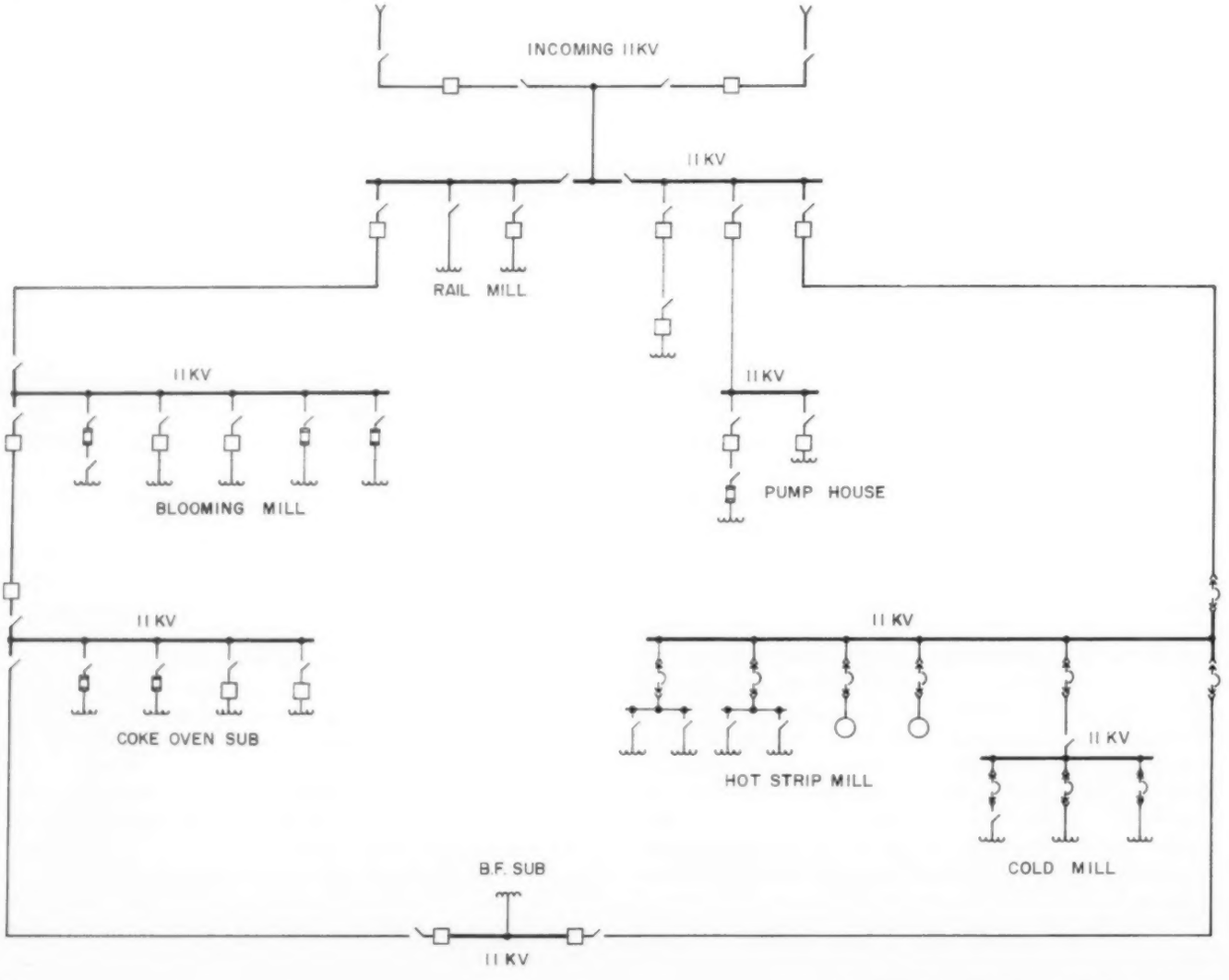
Overhead lines are relatively inexpensive and are easily repaired, but are vulnerable to weather and man-made accidents, need more space and can be a hazard to personnel.

Underground lead covered cable in underground duct encased in concrete is relatively trouble free when properly installed, but costs more than twice as much as an overhead system and is difficult to repair.

Lead covered steel tape armored cable buried directly in the ground has been used, but is very vulnerable to accidental disturbance.

In recent years, use has been made of neoprene covered flexible metallic sheath cable carried overhead

Figure 7 — This high tension distribution system is primarily a loop arrangement.



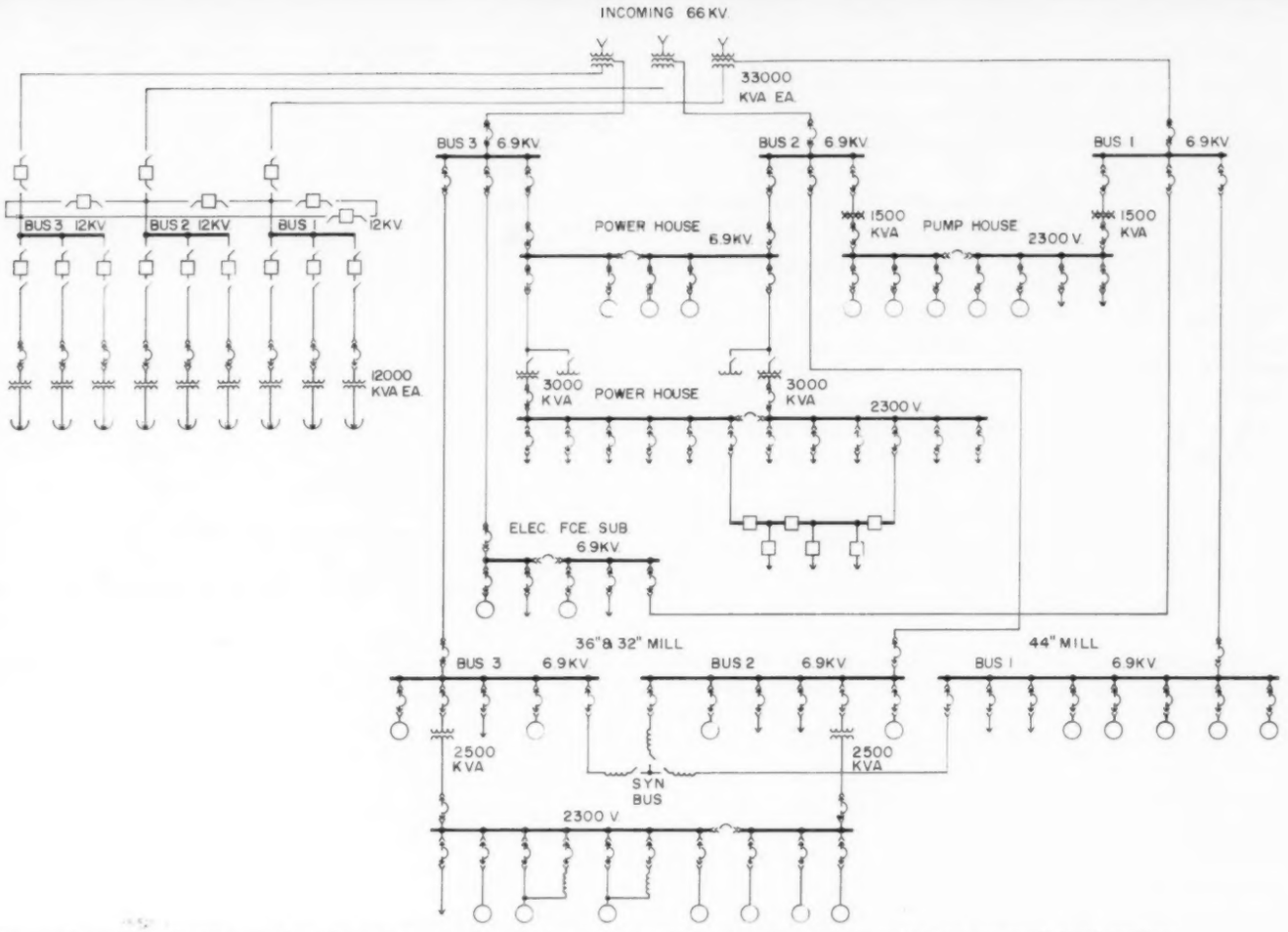
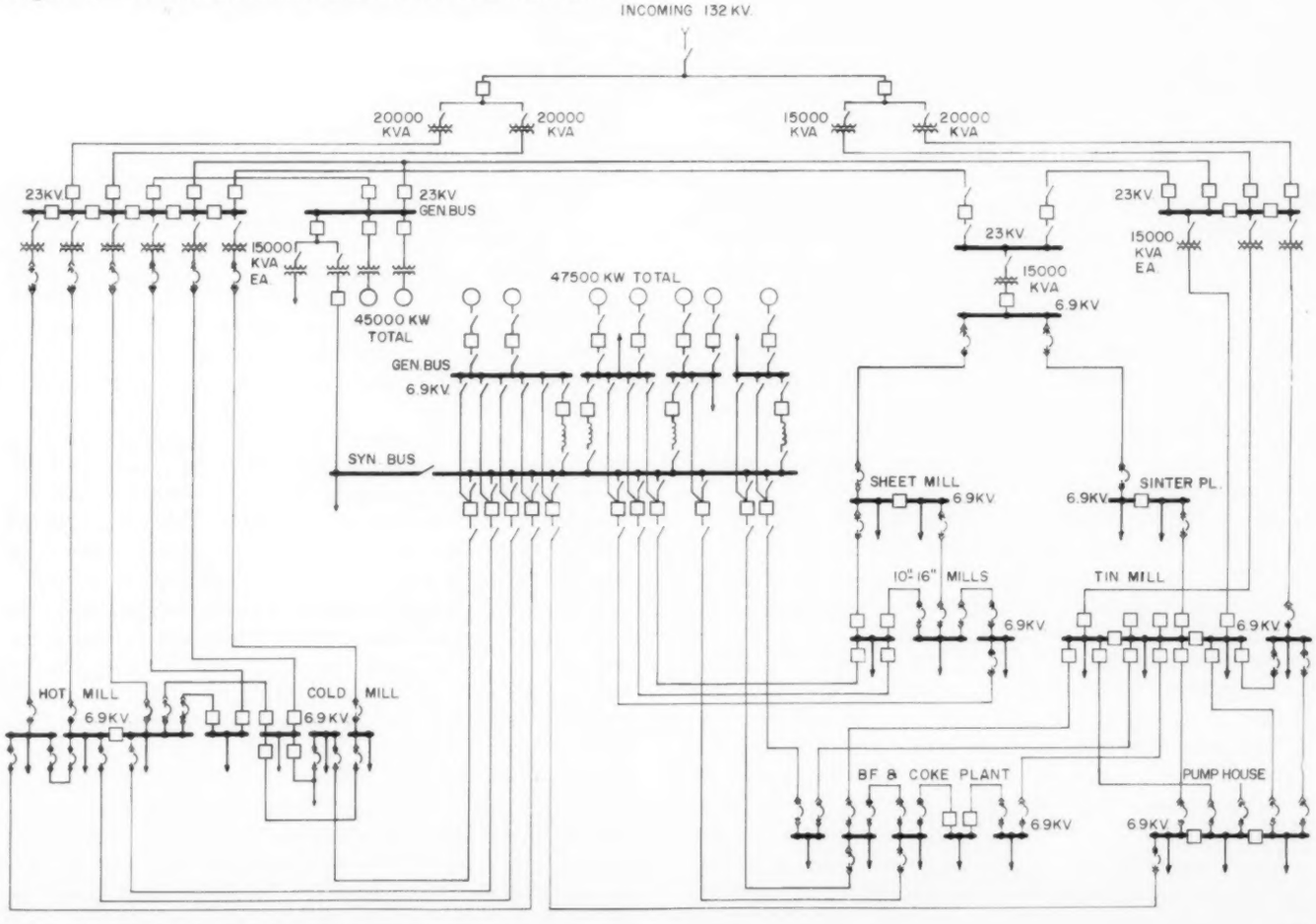


Figure 8 — Distribution system here is basically a primary selective system using two feeders to each load center.

Figure 9 — This network has extensive interconnections.



on messenger cable.

Among the factors to be considered in determining whether lines are to be overhead or underground, are nature of ground, drainage, congestion of buildings, and distances to cover.

D—Switchgear—Steel mills use circuit breakers almost exclusively for circuit interruption. Relatively little use is made of load break switches or fused disconnects, for safety reasons.

Circuit breakers must be chosen carefully for both current carrying capacity and short circuit interrupting capacity. Current carrying capacity is determined from load data. Interrupting capacity is determined by the maximum short circuit current that the breaker will be called on to interrupt, and is found by making a study of the system characteristics.

Indoor air circuit breakers are available at 500,000 kva interrupting capacity at voltages up to 15 kv. For greater interrupting capacity or for higher voltages up to 34.5 kv, station type cubicle breakers are used. Voltages over 34.5 kv use oil circuit breakers.

Steel mills have taken every possible advantage of developments in switchgear because of the emphasis put on safety, and the need for continuity of service. In fact, some of the severe service requirements of the steel industry, such as electric furnace breaker operation, have contributed to the rapid development of switchgear.

In recent years there has been wide acceptance of indoor metal clad factory assembled switchgear, for use up to 15 kv. The chief advantages of such switchgear are safety for personnel, and ease of maintenance.

Much use is made of low voltage a-c unit substations, with incoming disconnect, transformer, secondary breaker and feeder breakers factory assembled as a unit. They are compact, easily installed, and safe. D-c, 250 v unit substations are also used, with transformer, rectifier, cathode breaker and feeder breakers assembled as a unit.

Much use is also made of a-c motor control centers, factory assembled. The 250-v d-c motor control panels are much bulkier than a-c starters and cannot usually be factory assembled in the same manner. However, the modern trend is to assemble the d-c panels in groups in the plant and house them for better protection, ease of maintenance and increased safety to personnel.

E—Relaying—Protective relaying is an extremely important function in a power system. Faults must be located and isolated with a minimum of disturbance to the rest of the system.

Low voltage a-c and d-c motors usually have undervoltage and inverse time overcurrent protection. Low voltage feeders are protected by the feeder breaker overcurrent. Short circuits are cleared by the feeder breaker which usually has time overcurrent and instantaneous overcurrent features. Some use has been made of current limiting fuses for short circuit protection for motors and feeders.

Higher voltage motors in the larger sizes usually have differential protection and phase balance protection in addition to the normal overcurrent and undervoltage relays.

High tension feeders are a vulnerable part of the power system and a fault here can shut down large parts of the plant. Considerable attention must be given to the relaying.

TABLE II
Steel Plant General Relay Schedule

Unit \ Relay	Time over current	Instantaneous over current	Time over current to ground	Instantaneous over current to ground	Thermal over current	Current balance	Per cent difference	Difference to ground	Pilot wire	Undervoltage
6900 V										
Transformers	X	X	X	X			X			
Bus							X	X		
Main feeders	X		X						X	
Motors	X	X	X	X		X	X			X
2300 V										
Transformers	X									
Bus							X			
Feeders	X		X							
Motors	X	X			X	X				X

In a simple radial system, good protection can be obtained from time overcurrent relays. But as the loads get larger and the systems become more complex, there can be more breakers in series between the power source and the farthest fault point. The overcurrent relay time settings must overlap to get the necessary selectivity, and the point may be reached where a fault near the source can continue too long. In addition, such time settings may reflect back into the incoming power company system. About 35 cycles is considered the maximum allowable time to clear any fault within the plant for good co-ordination with the power company.

Parallel feeders present problems. The relay system must open the faulted line and leave the other line in operation. This can be done with overcurrent protection at the source end and reverse power relays or directional differential relays at the load end. The overcurrent time must overlap the reverse power time, so there is still the problem of selectivity.

In a primary loop system, protection by selective setting of overcurrent, differential, or reverse power relays becomes extremely difficult.

As a solution to some of these problems, considerable use has been made of pilot wire relaying. Feeders are installed with circuit breakers at each end. Relays at each end of a feeder are connected by a pair of small wires. The arrangement has a supervisory feature to indicate when pilot wire is in operation. The relays are designed and connected so that they are inoperative on normal loads or on through faults, but in case of fault in the line being protected they open the breakers at both ends simultaneously. The relays operate in about one to two cycles, and the fault is cleared with little damage.

On neutral grounded power systems considerable use is made of ground overcurrent and ground differential relays.

Main power transformers usually have differential relays in addition to overcurrent relays. High tension station busses frequently have differential protection.

Table II shows the general scheme of relaying in use in a medium size steel plant which purchases all its power, and whose distribution is basically a primary selective system. The instantaneous overcurrent features indicated are not used in all cases, and there are

certain other deviations in some instances.

Relaying is used for many other purposes, such as load sharing between steel plant and utility, voltage control, power factor control, etc. Relays are of many kinds, and their application is a specialized field.

F—System studies—Designing a power system for a modern steel plant requires a systematic study of all factors. The increasing concentration of power in such areas as strip mills has emphasized the importance of short-circuit protection in particular, as well as such things as voltage regulation and power factor control. The problem is further complicated if it is necessary to superimpose the new system on an old one, possibly a 25-cycle system.

The starting point for study is a one line diagram of the proposed system, or better, two or more alternative arrangements. The next step is the accumulation of necessary data, such as ratings of motors, generators and transformers with their impedance values, lengths and types of feeder lines, etc. Usually data for low voltage equipment is not included.

Having this information, it is possible to determine the performance of the system under various assumed normal and abnormal conditions. This can be calculated mathematically, but obviously such a procedure would be tedious and time consuming. A much better method is to have the system set up on a network analyzer which is in effect a miniature of the system being studied. There are many analyzers available for this purpose.

A series of tests is made under the various assumed conditions, test results are tabulated and analyzed and a report made. From the findings intelligent decisions can be made regarding voltages, circuit breaker ratings, relay settings, etc.

Such studies should be set up and followed closely by the steel plant engineer working with the consultants, with equipment manufacturers, and with the plant operating staff. The better the operating staff understand the system, the better will be the maintenance after the system is in operation.

Many steel plants have recognized the importance of studies of this kind. The value of such studies in the design of a power system cannot be overemphasized.

DETAIL DESIGN

A—Grounding—Good grounding in steel plants has been getting increased attention in recent years and is important for personnel safety, for good operation, and for the protection of underground pipe, particularly in connection with grounded neutral power systems.

The present standard practice is to locate a number of ground points over the area concerned. The points are connected to a grid system of buried heavy bare copper cable. A ground bus is installed in substations and motor rooms which is connected to the grid system. Building columns are also grounded, the copper ground wire being welded to the steel. In some cases, the ground systems in various areas are also tied together to make one integral ground system for the whole plant. All electrical equipment frames are solidly connected to the ground system.

B—Equipment location—The location of equipment is a matter of practical importance, and entails a number of considerations.

Equipment should be located where it will not interfere with mill operations, and where it will be unlikely to be moved in case of future plant expansion.

The relative location of various units of the system should be such as to promote simplicity of electrical connections. This is an especially important consideration in motor rooms.

Safety is an important consideration, both safety to personnel and safety to the equipment. A motor control center, for instance, protects personnel, but must be located where it cannot be damaged by such things as crane loads or tractors. Exposed parts of the system, such as open bus or switches, must be located for maximum protection.

C—Liberality in design—Steel mill engineers have found by experience that it is sound practice to be liberal in design with respect to some parts of a power system, for two reasons. One is the probability of additional load, and the other is the rugged service conditions encountered in steel mills.

It is common practice to carry higher insulation levels than called for by nominal requirements. For instance, 6.9-kv overhead lines are usually carried on 15-kv insulators and 6.9-kv underground cable has 15-kv insulation, not that it is exposed to bad atmospheric conditions, but because transients are prevalent in a steel mill system. The 550-v equipment, when used, usually is wired with 1000-v wire.

It is also common practice, when installing metal clad switchgear, particularly low voltage switchgear, to have at least one empty circuit breaker compartment. The same policy is followed when installing a-c motor control centers.

Underground duct banks for high tension cable usually have at least one spare duct. Moreover, several smaller duct banks with fewer ducts are preferred to a single duct bank with a larger number of ducts.

When installing conduit for low voltage motors and control, wherever there is a group of conduit from one point to another spare conduit are always included. It has become standard practice to have 15 to 20 per cent spare conduit.

Low voltage switchgear, a-c motor control centers and groups of d-c control panels are often installed over a conduit trench. Individual conduit need not be brought to a particular location at the switchgear. This avoids crossing of conduit underground and facilitates installation, and makes wiring of added equipment easier.

D—Lighting—Lighting is of considerable importance in a steel plant power system. The lighting load can be up to 10 per cent of the total plant kwhr and lighting distribution deserves careful planning.

Most of the lighting load is general purpose mill lighting requiring about 20 foot candles at the working level. Mounting heights are usually 25 feet or more. For many years the standard practice was to use 500-w, 750-w or 1000-w incandescent lamps connected to the 110/220-v secondaries of single phase transformers ranging from 5 to 50 kw capacity.

It is becoming present day practice to use color-corrected mercury vapor lamps, connected directly to 440-v distribution lines. Some plants, operating on a

grounded neutral system, use a 440-v four wire system, with the lamps operating on line to neutral voltage.

SUMMARY

Designing a power system for a steel plant is not a simple task. Besides the matters discussed briefly in this paper, there are many other things to be considered. It is apparent that the power system for each plant is unique, although basic principles apply in all cases.

The problem must be approached logically and systematically. The importance of the various factors must be recognized. A systematic study must be made and logical conclusions drawn, and the system designed and installed in accordance with those conclusions, the ultimate aim being to supply power for steel plant operation with an optimum balance between reliability and cost.

The list of references in the Bibliography covers some of the many papers and books that have been published covering various phases of steel plant power systems.

The author wishes to acknowledge the valuable assistance given by several steel companies in preparing the paper.

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Available Translations

As a service to readers of the Iron and Steel Engineer a list of translations from foreign articles is being printed intermittently. Articles selected for this listing will be those thought to be of primary interest to the American steel plant operator. The papers may be obtained from the Cooperative Translation Service, The Iron and Steel Institute, 4 Grosvenor Gardens, London, S. W. 1, England. All correspondence concerning price, ordering, and so forth should be directed to one of the preceding sources.

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Figure 1 — Few plants have such a beautiful background setting as the Geneva works.

COAL CHEMICALS IN INDUSTRY

by L. G. Bywater, Superintendent, Nitrogen Plant
Geneva Works, Columbia-Geneva Steel Div., United States Steel Corp., Geneva, Utah

The new nitrogen plant at the Columbia-Geneva Steel Works of U.S. Steel is illustrative of the trend to the production of more and more chemical products from the coke plant.

A SIGNIFICANT milestone in the industrial progress of the Intermountain West was marked early in 1957, when a new nitrogen plant went on stream at Geneva Works of U. S. Steel, near Provo, Utah. The only chemical plant of its kind to be located at major, integrated steel plant in this country, the new facility was built to reap more of the golden harvest of important chemicals derived from coal.

For decades, U. S. Steel, "The industrial family that serves the nation," has been a recognized leader of progress in the steel industry. However, relatively few Americans realize that U. S. Steel has been and is pioneering much of the nation's coal chemical industry—an industry so vital to modern society that, in a normal day, it would be impossible not to be within sight or touch of some product that originated in a lump of black, shiny coal.

This year, 1958, will witness the 50th anniversary of coal chemicals in U. S. Steel, for it was a half-century ago that the first battery of coke ovens, specially designed to capture the gases from coking coal, began operation at the Joliet Steel plant in Illinois. Since then, the new products—ranging from aspirin to nylon hosiery—that have been developed from coal chemicals

Figure 2 — The coke ovens provide the raw materials for many chemical products.

Figure 3 — The basic process of the nitrogen plant was originally developed in Germany.

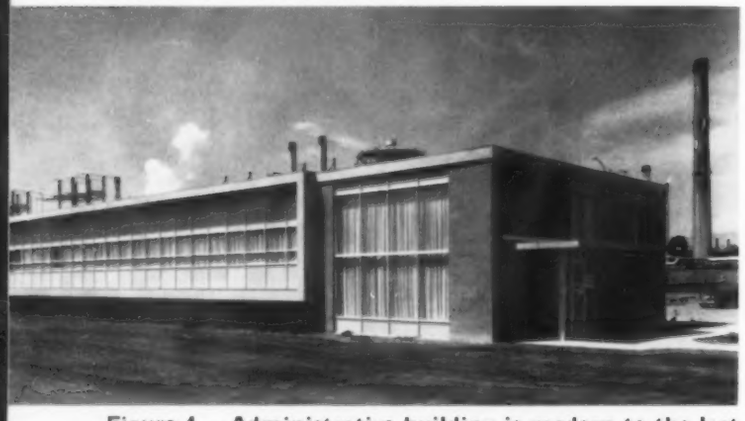


Figure 4 — Administrative building is modern to the last detail.

Figure 5 — Coke oven gas is held in gas storage tanks before being delivered to compressors.

have been numbered in the thousands, with thousands more awaiting discovery.

It was in keeping with this demonstrated leadership over the years that U. S. Steel became the first American steel producer to build a facility like the one now in full production at Geneva Works. The decision to erect the new plant at Geneva for the production of the nitrogen products—anhydrous ammonia, ammonium nitrate and nitric acid—was based on several important considerations.

Most important of these was to locate the market area having the greatest potential for nitrogen chemicals. To pinpoint this area, teams of marketing and sales specialists began an exhaustive study of published information. Supplementing the data they compiled were hundreds of hours spent and thousands of miles traveled to study and visit all potential market areas to measure their scope and location.

The results from this extensive effort all pointed to the same conclusion. This was to build the new plant at Geneva Works, located in the very heart of the Intermountain West. It was here that the need for nitrogen products was greatest and where the most growth potential lay for the future. Intermountain area soils, while rich in most plant foods and minerals, are usually nitrogen-poor, forming an ever-growing market for commercial nitrogen fertilizers, such as anhydrous ammonia, ammonium nitrate and ammonium sulphate, for western farms and ranches. Nitrogen is also a vital ingredient in the processing of uranium ores and concentrates.

The combination of these factors resulted in the decision to build the new Nitrogen Products Plant at Geneva Works, "The Mill O' The Mountains," operated by U. S. Steel's Columbia-Geneva Steel Division. See Figure 1. Lying near the base of the 12,000-ft Mount Timpanogas, a short distance from Provo, Utah, Geneva boasts one of the most scenic settings of any integrated steel mill in the world.

The basic ingredients for ammonia synthesis were available at Geneva Works (Figure 2) in the forms of coke oven gas and a limitless supply of air. Coke oven gas yields a rich supply of hydrogen; the earth's atmosphere is correspondingly rich in nitrogen. Ammonia is produced when one part of nitrogen in united with three parts of hydrogen. This union, however, is not easily accomplished. Combining air with the vapors from coke ovens makes the nitrogen products story interesting.

The nitrogen plant (Figure 3) at Geneva Works is a composite of the finest in materials and methods to be found in the United States. The basic synthesis process on a commercial scale was developed in Germany in 1914 and, while the Geneva plant is new to this country, European manufacturers have utilized coke oven gas in this manner for more than 30 years.

The clean, functional lines of the administration building (Figure 4) reflect the modern nature of this operation, right down to the last detail. Many varied U. S. Steel products were used in its fabrication, including enameled steel panels used for decorative outer walls.

There are many people who are familiar with steelmaking processes and know that extremely high temperatures are involved. They also are aware that steelmaking utilizes materials that can be seen and felt.

Figure 6 — Certain undesirable products are removed in the purification towers.

However, in the manufacture of nitrogen products the process begins with a raw material that can neither be seen nor touched—coke oven gas. This fuel is delivered to our gas compressors from the gas storage tank (Figure 5) in the coke oven area. Approximately fifty per cent of this gas is hydrogen by volume. This whole gas must now be separated into its usable parts.

In the coke oven gas purification equipment (Figure 6) certain undesirable gases are removed and used in the manufacture of sulphuric acid. The purified gas stream now enters a pre-cooling unit, where its temperature is reduced and additional fractions are removed.

From the free air, a gas stream is pulled through a filter, compressed, cooled, liquefied and separated into its various components. The nitrogen stream is pumped to a "cold box" (Figure 7) along with the hydrogen gas stream, where the temperature is reduced to a minus 320 F.

The insides of a cold box (Figure 8) consist of a serpentine complex of piping and tubing. To insulate for the temperature extremes that are required, 500 ton of rock wool were literally stuffed and crammed into the spaces between the pipe work.

At a very low temperature the hydrogen and nitrogen streams are united and pass from an additional compressor stage (Figure 9) to a synthesis converter where, in the presence of an iron catalyst, the synthesis gas is chemically converted to anhydrous ammonia.

In its liquid form, anhydrous ammonia is stored at about four times atomospheric pressure in two 2100-ton capacity hortonspheres (Figure 10) which are 60 ft in diameter.

The problems of pressure and temperature can be appreciated fully only after close association with the nitrogen products operation. However, the specially designed compressors—among the largest ever constructed—give some indication of the operation's magnitude. See Figure 11.

To maintain this equipment and to keep production moving requires the most accurate and sensitive kinds of control devices (Figure 12). In the plant's "nerve center," numerous dials and graphs keep a constant check on hundreds of production processes.

From the storage spheres, liquid ammonia is drawn for further processing in the plant and for shipment to customers for direct soil application. In the nitric acid area of the plant, ammonia and free air are united and

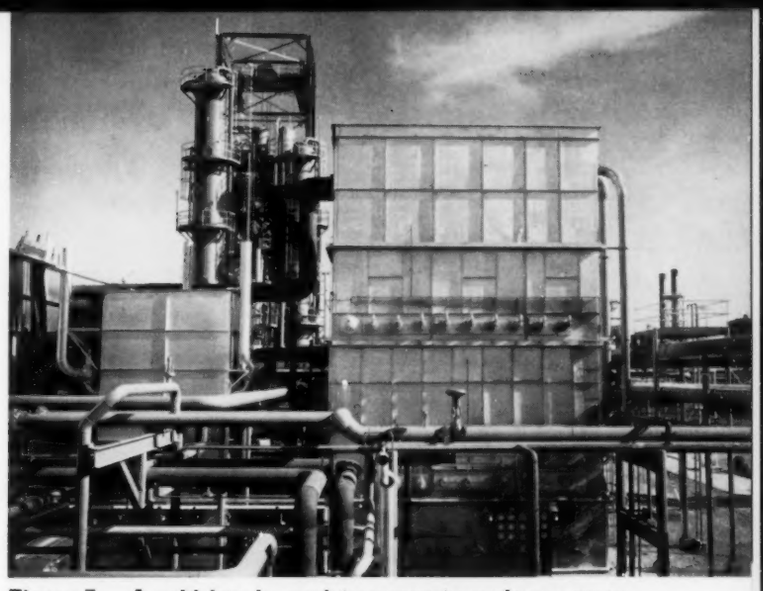


Figure 7 — A cold box is used to separate various components.

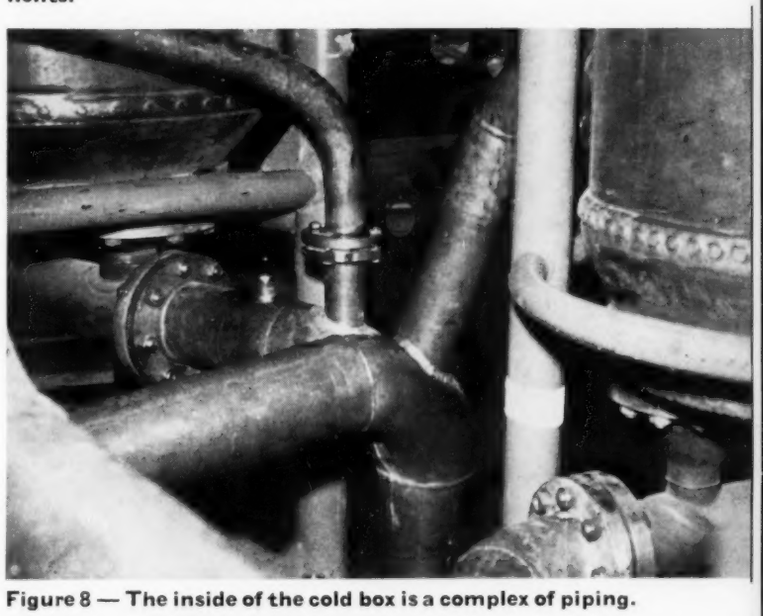


Figure 8 — The inside of the cold box is a complex of piping.

Figure 9 — Synthesis gas is chemically converted to anhydrous ammonia after going through compressor shown.

burned over a platinum catalyst to produce nitric acid.

The ammonia and free air combination is further oxidized with air, then bubbled up through water inside

Figure 10 — Anhydrous ammonia is stored at about 60 psi.

Figure 11 — Some of the largest compressors ever built are used in the process.

stainless steel absorbers (Figure 13) which are called "cascade absorbers." There are twenty of these stainless steel tanks in operation. The final process yields 53 per cent nitric acid.

From the hortonspheres, anhydrous ammonia is pumped to the ammonium nitrate plant, where it is united with nitric acid. In the neutralizer tank, it forms an ammonium nitrate solution. Ammonium nitrate may be sold in solution or may be dehydrated to form solid ammonium nitrate. This form of nitrate is produced by pumping the solution to the prilling tower (Figure 14). The ammonium nitrate solution is sprayed from the top of the prilling tower. As the spray falls 160 ft toward the floor, it is cooled by a countercurrent of air and forms shot size spherical prills. These prills are recovered on a conveyor system, coated with diatomaceous earth to prevent caking, and finally bagged for ease in handling and shipping.

United States Steel is serving both agricultural and industrial consumers with the products of this new plant. From Geneva Works, there are three nitrogen products moving to the agricultural market place. Anhydrous ammonia and ammonium nitrate come from the new nitrogen facility. Ammonium sulphate is a long-time product of the coke and coal chemicals recovery facilities. Recently, a new granulator was installed, and the ammonium sulphate product is now in a convenient, free-running granular form.

As indicated earlier, anhydrous ammonia (82 per cent nitrogen) is handled as a gas under pressure and may be applied directly into the soil through the use of special applicator rigs or injected into irrigation water. These methods of enriching the earth are growing in popularity in most farm regions.

Anhydrous ammonia is also used by two Intermountain companies as an ingredient in the manufacture of ammonium phosphate which is, in turn, a widely accepted fertilizer material.

Ammonium nitrate is a solid prilled material (Figure 15) which can be distributed conveniently through the use of an ordinary tractor spreader attachment. Ammonium nitrate contains 33½ per cent nitrogen. With

Figure 12 — Accurate and sensitive control advances are required to check the various production processes.

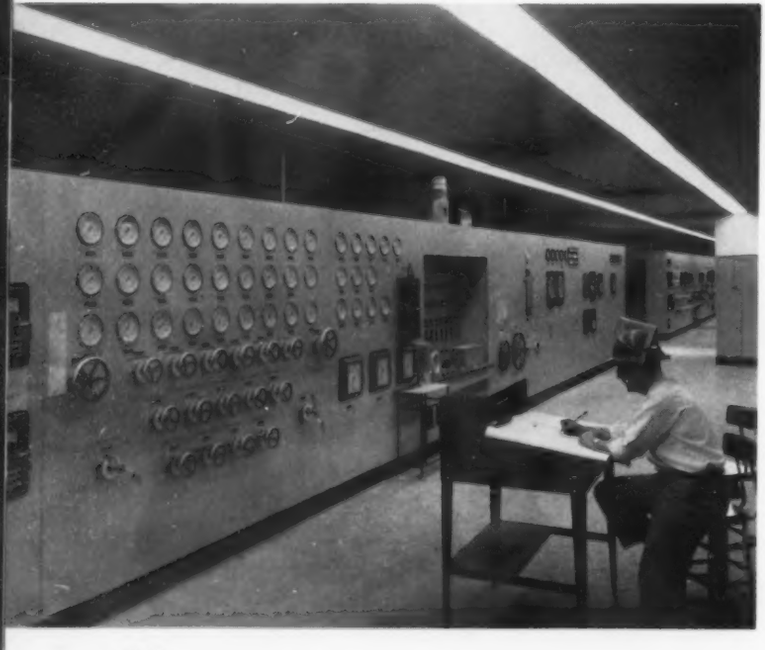
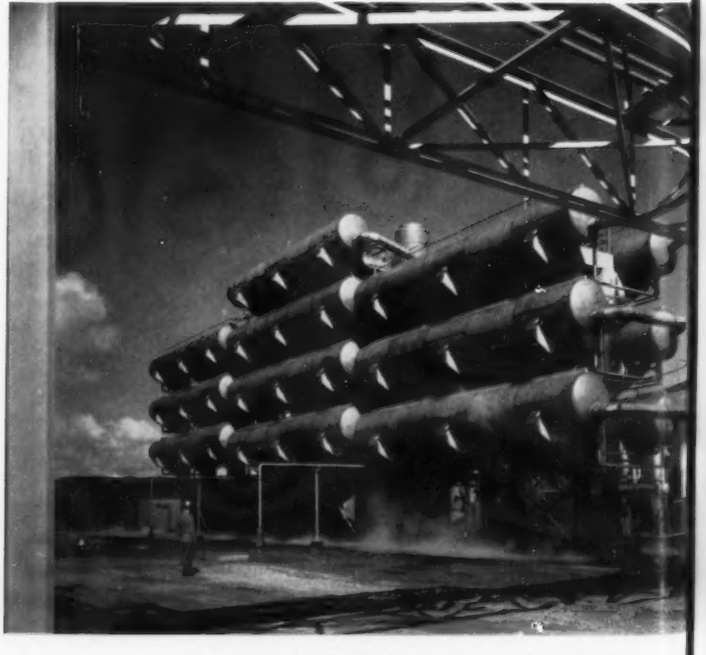


Figure 13 — Cascade absorbers are used in nitric acid process.



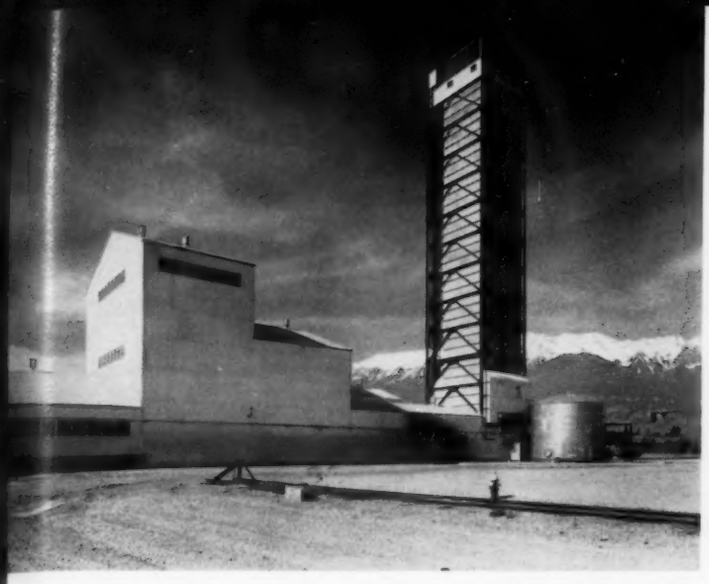


Figure 14 — Solid ammonium nitrate is produced in the prilling tower.

these three nitrogen bearing fertilizers available to them, farmers will find U. S. Steel's Geneva Works a diversified source of plant food. This diversity will permit a choice of material to fit individual needs and problems.

Some of the industrial uses for nitrogen include ammonia used for algae control in water purification systems: a special grade is also used as a refrigerant. One of its most significant uses is in uranium ore processing to precipitate uranium from solution. At Geneva, a portion of the ammonia produced is used to manufacture nitric acid and ammonium nitrate.

Nitric acid produced at Geneva Works primarily serves the uranium and other rare metals industries. As indicated earlier, nitric acid is also used in combination with anhydrous ammonia to make ammonium nitrate.

One other valuable product comes on stream at Geneva with the nitrogen. In the process of taking nitrogen from the atmosphere, limited quantities of oxygen are also recovered. Oxygen is important to the manufacture of high quality steel. At present, Geneva consumes most of the oxygen produced and plans have been formalized which will call for the use of the plant's total oxygen production. See Figure 16.

Consistent with U. S. Steel's policy of safety first, the nitrogen products plant was constructed with safety uppermost in the minds of its planners. Coupled with numerous safety-engineered features, a work-safe program has been developed and tailored to the specialized operation. Effective instruction and first quality protective equipment combine to form a thorough safety program.

The new nitrogen products plant (Figure 17) at Geneva Works is a major demonstration of how United States Steel's continued faith in a growing West has resulted in a big step forward on the industrial horizon. The nitrogen products turned out here will have considerable impact on the industrial and agricultural countenance of the Intermountain area.

The knowledge of what new, useful products will come from coke oven gas belongs to the future. But, in the light of the past, the future does seem encouraging. United States Steel's nitrogen products plant at Geneva Works is symbolic of that future. ▲

Figure 15 — The prilled ammonium nitrate can be distributed with ordinary tractor attachments.

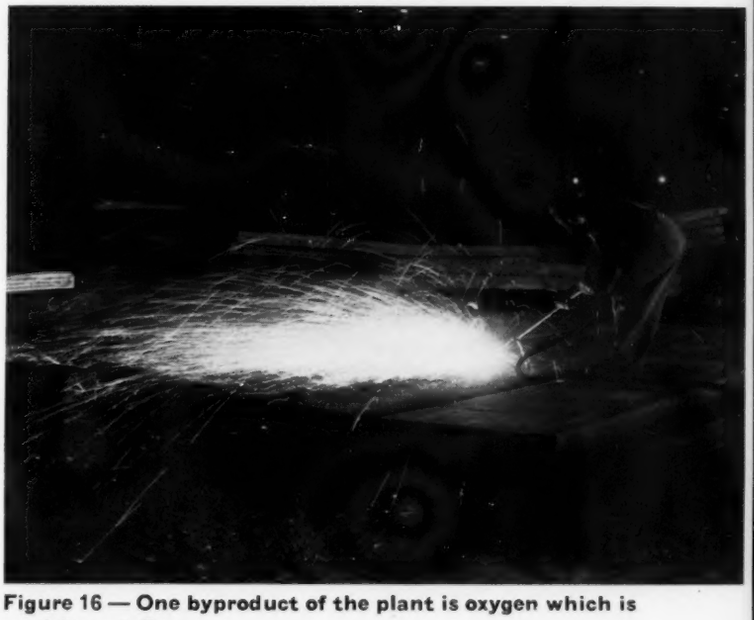


Figure 16 — One byproduct of the plant is oxygen which is used for scarfing.

Figure 17 — The new nitrogen products plant will aid in the development of the western area.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, November 24, 1958—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Alabama Rivers Development Programs," by Neely Henry, Executive Vice President, Alabama Power Co., Birmingham, Ala.

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Tuesday, November 11, 1958—Dinner 6:30 P.M., Meeting 8:00 P.M.

"Design, Construction and Maintenance of Overhead Cranes," by John Bird, Laboratory Metallurgist and John Witts, Crane Design Engineer, Steel Company of Canada, Ltd., Hamilton, Ontario, Canada

Hotel Sheraton, Buffalo, N. Y.

CANTON SECTION

Details Not Available

CHICAGO SECTION

Tuesday, November 4, 1958—Dinner 6:15 P.M., Meeting 7:45 P.M.

"The Role of the Industrial Engineer in the Steel Industry," by John E. Angle, Vice President, Industrial Engineering, United States Steel Corp., Pittsburgh, Pa.

Phil Smidt's Restaurant, Hammond, Ind.

CLEVELAND SECTION

Tuesday, November 18, 1958—Social Hour 6:00 P.M., Dinner 6:30 P.M., Meeting 8:00 P.M.

"Snake Charmers Impressions of Yankees," A Panel presentation by members of INSTEP*. * (Indian Steel Training and Educational Program.)

Cleveland Engineering and Scientific Center, 3100 Chester Avenue, Cleveland, Ohio

DETROIT SECTION

Tuesday, November 11, 1958—Dinner 6:30 P.M., Meeting 8:00 P.M.

"Electrical Concentration of Iron Ore," by M. Bruce Mairs, Manager-Minerals Dressing Dept., Joy Manufacturing Co., Pittsburgh, Pa.

Parlors E, F, and G—Engineering Society Building, Detroit, Mich.

LOS ANGELES SECTION

Monday, November 10, 1958—Social Hour 6:15 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Recent Application of Gear Type Spindles," by Fred H. Paddon, Manager, Engineering Sales, Amerigear Bliss Spindles, E. W. Bliss Co., Salem, Ohio.

Michael's Restaurant, 6309 E. Washington, Los Angeles, Calif.

PHILADELPHIA SECTION

Saturday, November 1, 1958—Dinner 6:00 P.M., Meeting 7:00 P.M.

"Vacuum Pouring for Degassing Large Ingots at Bethlehem," by Henry C. Bigge, Superintendent, Tool Steel & Electric Furnace Melting Depts., Bethlehem Steel Co., Bethlehem, Pa.

Engineers' Club, 1317 Spruce Street, Philadelphia, Pa.

PITTSBURGH SECTION

Monday, November 10, 1958—Inspection Trip 1:30 P.M., Dinner 6:30 P.M., Meeting 8:00 P.M.

Inspection Trip: Weirton Steel Co., Div. of National Steel Corp., Weirton, W. Va. Assemble at Weirton Community Center.

"Advances at Weirton," by L. A. Fugassi, Assistant Chief Engineer, Weirton Steel Co., Div. of National Steel Corp., Weirton, W. Va.

Dinner and Meeting, Main Ballroom, Fort Steuben Hotel, Steubenville, Ohio

ST. LOUIS SECTION

Wednesday, November 19, 1958—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Application of Oil-Film Bearings," by Samuel Carson, Field Engineer, Morgan Construction Co., Worcester, Mass.

Elks Club, Granite City, Ill.

SAN FRANCISCO SECTION

Tuesday, November 18, 1958—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Recent Trends in Steel Mill Refractories," by N. W. Roudabush, Manager of Basic Sales and Technical Service, H. K. Porter Co. Inc., Refractories Div., Pittsburgh, Pa.

Shattuck Hotel, Shattuck & Alston Way, Berkeley, Calif.

UTAH SECTION

Utah District

Monday, November 10, 1958—Social Hour 6:30 P.M., Dinner 7:30 P.M., Meeting 8:30 P.M.

"Gas Turbines for Blast Furnace," by George H. Krapf, Division Superintendent, Power Production, South Works, United States Steel Corp., Chicago, Ill.

Grandview Cafe, Provo, Utah

Pueblo District

Tuesday, November 18, 1958—Social Hour 6:30 P.M., Dinner 7:30 P.M., Meeting 8:30 P.M.

"Relocation of Merchant Finishing Operations," by Frank Carey, Assistant to Superintendent, Rolling and Finishing Mills, The Colorado Fuel and Iron Corp., Pueblo, Colo.

Minnequa University Club, Pueblo, Colo.

YOUNGSTOWN SECTION

Monday, November 24, 1958—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Program Control of Hot Strip Mills," by L. E. Weingard, Sales Representative, International Business Machines Corp., Pittsburgh, Pa., and John McCarthy, Assistant Superintendent, Bloom, Strip and Rolling Mills, Jones & Laughlin Steel Corp., Aliquippa, Pa.

Mahoning Country Club, Girard, Ohio

Large Motor Bearings

by Walter T. Saveland, Jr.,
Supervisory Engineer,
Renewal Parts and Service,
Motor and Generator Dept.
Power Equipment Div.,
Allis-Chalmers Manufacturing Co.,
Milwaukee, Wis.

. . . . both anti-friction and fluid-film bearings are used on large motor drives . . . . the effectiveness, efficiency and dependability of these units are largely dependent on careful bearing design, installation and maintenance . . . .

THE introduction of the electric drive was a most important stepping stone in the progress of the iron and steel industry. The continued application of new processes and the improvement of existing procedures are in many cases dependent on refinements of these drives.

There are basically two types of bearings in use for both large and small electric rotating machines. In some cases these are quite similar, but in many instances requirements and usage result in differences. To classify electric machines by size of horsepower rating is rather indefinite, and for the purpose of this discussion, there is no real need to specify the size of equipment.

FLUID FILM BEARINGS

One of these bearing types the author would like to term the "fluid film" bearing. This includes the sleeve type bearing for radial loading as well as the collar or flange and shoe type bearings for thrust loading. There are other specialized bearings but these are not used for large motors.

In practice the sleeve bearing is usually furnished with an integral flange to take care of some thrust loading. Also in practice the sleeve bearing and the tilting shoe bearing depend for their satisfactory operation on complete separation of the metal parts. The flanged bearing may also be designed to give complete separation of the metallic parts but more frequently that is not the case and will be mentioned again later on.

ANTI-FRICTION BEARING

The other general category of bearings is the anti-friction type. This includes ball bearings, which may be utilized for radial or thrust loadings and combinations of these loadings. It also includes the spherical roller bearing which is suitable for thrust and some radial loading, the tapered roller bearing for thrust and radial loading, and the plain roller bearing for radial loading.

LUBRICATION

Neither of these two groups of bearings will operate without use of a suitable lubricant. Oil is required as a lubricant to separate the moving parts of fluid film bearings to prevent or minimize wear. Extremely large heavily-loaded bearings, such as flywheel bearings, sometimes require a high-pressure oil lift system to prevent minor but repeated wiping of the babbitt during the initial movements of starting or to reduce the breakaway torque to a value that is within the limits of the driving motor and the electrical supply. Oil rings, viscosity pump, slingers, flood lubrication or an oil bath, or combinations of these are required for all of these bearings.

Once the oil is in intimate contact with the moving parts, this contact can utilize the viscosity of the oil to generate an "oil wedge" for complete separation of metallic parts. This lubricant also serves to prevent rusting during operation and during normal duration shutdowns.

The primary objective in using an oil or grease lubricant for anti-friction bearings is to separate sliding parts to prevent or minimize wear. Such sliding may be between balls and retainer or at roller ends. The lubricant is furnished by providing grease in the bearing closure, or in the case of oil lubricated bearings by means of an oil bath, oil rings or oil mist. These lubricants also serve to prevent rusting during operation and to defer rusting during shutdowns. In many cases grease is also used as a sealing agent to assist in the prevention of entrance of contaminants through the shaft seals.

Years of study and effort have gone into the development and selection of various lubricants for many types of machinery as well as the application of these lubricants to specific purposes. Some of this work has been done by the manufacturers of rotating electrical equipment, and in many cases by those responsible for the operation of such equipment in the iron and steel industry. Producers of various lubricants are constantly taking steps to improve their products.

An oil for a fluid film bearing should have a viscosity to suit the peripheral speed and loading of the bearing. Motor manufacturers furnish recommendations for their equipment and the chart shown as Table I generalizes such recommendations. Those responsible for the operation of the equipment can minimize the grades of oil kept on hand but may not be able to limit themselves to one specific oil. Oils are furnished with additives for different purposes; however, most of these additives are not needed for motor bearings. All of these additives do have useful and necessary functions in many other types of equipment.

TABLE I
Oil Viscosity Vs Sleeve Bearing Motor Speed

SUV at 100 F	Speed
150–250	High speed
250–350	Medium speed
350–450	Low speed

Some of the anti-friction bearing requirements are such that they must be lubricated with oil. Large high-speed ball bearings require relatively light oils. The lower speed anti-friction bearings, particularly spherical and tapered roller bearings would require heavy oils. Again, the motor manufacturer would make a recommendation. Certain anti-friction bearing applications provide for grease lubrication. In general, these are lower speed applications when considering the relative size of the bearing in conjunction with rotative speed. It is usually found necessary to use "channeling greases" at higher operating speed to avoid excessive temperatures.

The wrong grease or oil can ruin an anti-friction bearing. Packing such a bearing full of a soft grease may result in enough heat to break up the retainer, destroy the temper of the balls and even cause the balls to become hot enough to become plastic. Too heavy an oil used in a slinger arrangement will not provide adequate lubrication as the droplets would not be small enough to form an oil mist. The motor manufacturer should also make a recommendation in such an instance. In all cases the lubricant serves an additional purpose in transmitting heat away from the working parts of the bearing.

DESIGN OF SLEEVE BEARINGS

The design and construction of sleeve bearings is most important to their successful operation. There must be an arrangement of openings to permit the passage of and to facilitate the entrance of oil into the working areas. The oil must be directed toward the formation of the "oil wedge." There must also be a provision for discharge of oil from this wedge and for discharge of the excess oil which serves the purpose of cooling the bearing.

During normal operation, the shaft is supported on an oil film about 0.001 to 0.006 in. thick (depending on speed, pressure and viscosity) near the bottom and extending over approximately the lower one-third of the bearing surface. These conditions are true for direct-connected motors of all sizes because the load on the bearing is vertically downward. Figure 1, an exaggerated schematic cross-section of the central portion of such a large bearing, shows typical reliefs and the position of the journal during normal operation. It is desirable to provide large clearance areas in the side and top portions of large and high-speed bearings to facilitate the movement of the oil and to minimize the generation of heat. If a smaller motor is under consideration, provision may be required for a horizontal component of load because of a belt or comparable drive, and large side reliefs may not be possible.

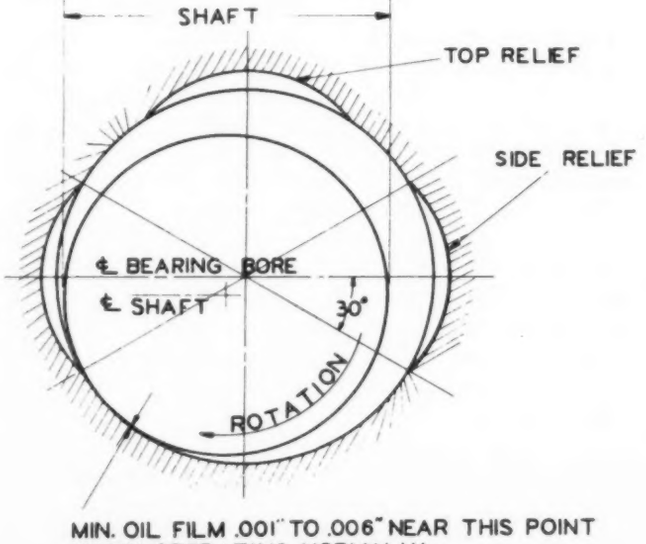
Ring oiled bearings as well as flood lubricated bearings must have the arrangement of passages developed as to distribute the oil across the width of the bearing where it can readily be directed into an effective "oil wedge." It is becoming the more usual practice to have flood lubricated bearings arranged so that the top half of the bearing can be removed without disturbing any oil piping.

These bearings are furnished with a cast iron or cast steel shell and it is advantageous to have the babbitt chemically bonded to the shell to assure permanent intimate contact of the babbitt with the shell. This eliminates the possibility of gradual loosening of the babbitt from the shell and provides for good heat transfer through the chemical bond. High grade lead base babbitts are ideally suited for many applications, but where these are not desired, tin-base babbitts are always satisfactory.

Large bearings should have spherical mountings to permit self-alinement with the journal. Smaller bearings with moderate width straight seats also have an equivalent self-alining feature. Proper initial machining of the bushing bore will eliminate in most cases the need for fitting a bearing to the journal; however, it is advisable to check this fit with the lower half of the bushing in position when making a replacement. Excessive fitting that will result in equally close contact over a large sector of the bearing causes higher temperature operation and may prevent formation of an effective oil wedge.

Seals are a very necessary feature of any motor bearing assembly and serve several purposes. They keep

Figure 1 — Diagram of bearing reliefs and relation of shaft to bearing (exaggerated for clarity).



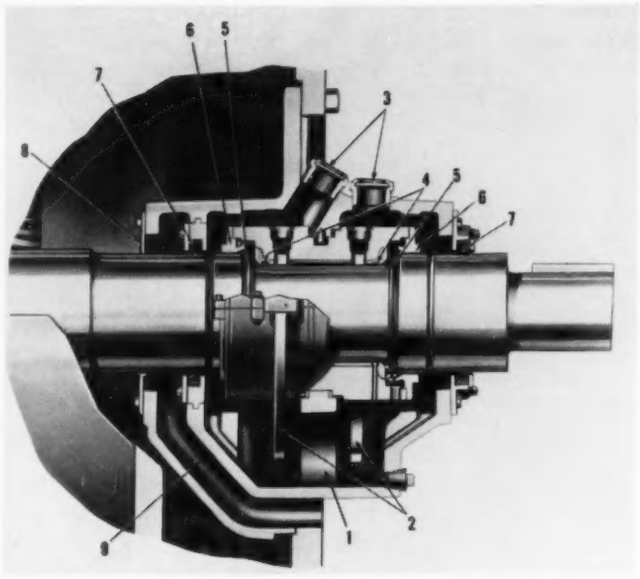


Figure 2 — Cutaway view of typical capsule-type bearing for low-speed operation (see text explanation).

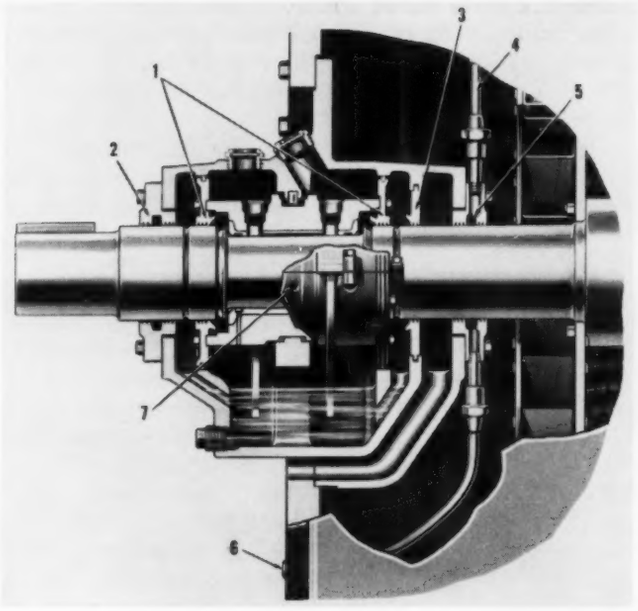


Figure 3 — Cutaway view of typical capsule-type bearing modified for high-speed operation (see text explanation).

liquid oil and oil vapor within the closure and keep contaminants out. Figure 2 is a cut-away sketch of a moderate or low-speed capsule-type bearing closure. The number 6 points out a clearance-type labyrinth bushing seal used to restrain oil spray; and (7) illustrates a rubbing-type synthetic seal used to prevent the passage of oil or oil vapors from the bearing closure. Note also that Figure 2 illustrates sealed bulls-eye type oil ring inspection windows. This capsule is mounted into the motor end shield and the inner end of the closure is subject to suction created by the rotor fan. The chamber (9) provides atmospheric pressure at the inner end of the closure to eliminate the effects of this suction.

If the peripheral speeds become too high because of high rotational speed or large diameter, the rubbing synthetic seals must be replaced by labyrinth-type clearance seals. In the case of pedestal construction, the chamber (9) is not required.

Modification of this design for high-speed operation is illustrated by Figure 3. In this case the bushing seals (1) are extended radially to the capsule wall and return passages at each end of the closure are brought in below the oil reservior level to prevent oil spray and vapor from leaving the bearing and oil ring area. The atmospheric chamber is again provided at the inner end of the bearing, but because of the extremely high fan suction an additional chamber is provided with air supplied through this chamber by piping (4) from the fan discharge and this pressure is relieved by an additional atmospheric passage (6). An arrangement of this effectiveness is absolutely necessary in the case of large high-speed motors. Number 7 illustrates how oil for flood lubrication is brought into the bearing below the centerline.

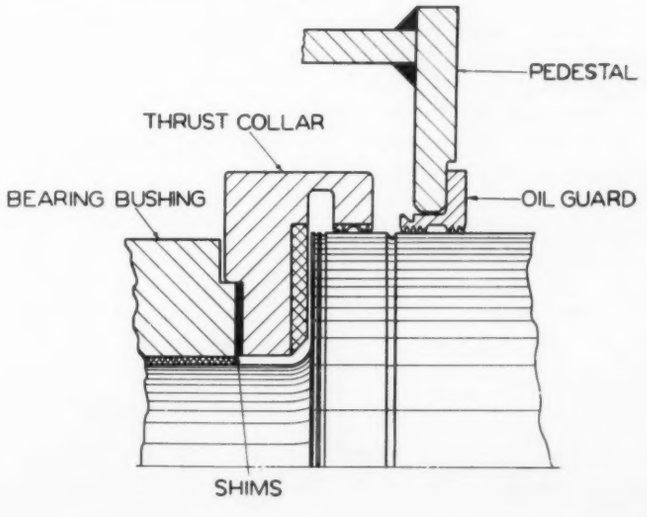
Auxiliary features are sometimes required with sleeve bearing installations. High pressure oil lift for start-up has already been mentioned. To obtain this, provision must be made for introducing oil at high pressure into the lower portion of the bearing. The arrangement must be such that each of the bearings that has oil lift is individually supplied so that each will be separately lifted.

Flood lubrication is sometimes provided for by means of a pump integral with the driven unit. This is often the case for a pump drive. Sometimes the supply is from a separate small motor-driven pump; occasionally it is by means of a pump directly connected to the driving motor shaft. Frequently such flood lubrication setups incorporate water cooling, although some motors are furnished with their own integral shaft-driven pumping arrangement and self air cooling.

As an alternate to flood lubrication, in some cases involving very large bearings, water cooling is used. This can be provided by embedding a cooling coil in the babbitt. Where a separate coil is used in the oil bath such a coil should always be completely immersed in oil to prevent condensation of moisture.

Bearing insulation to prevent shaft currents is frequently required on larger machines and motor-generator sets. In many machines the electrical characteristics are such that a circuit would be completed through the shaft, bearings, pedestals and base or equivalent parts with sufficient voltage impressed across

Figure 4 — Typical mill-type thrust bearing arrangement.



the oil films of a sleeve bearing arrangement to cause arcing and pitting of the babbitt and shaft journals. In such cases the outboard bearing of a two bearing machine and all but one of the end bearings of a motor-generator set must be insulated to prevent circulating currents. Those responsible for the maintenance of this equipment must take care that this insulation is not made ineffective by abuse, dirt or paint. It is desirable to occasionally check the installation to ascertain that this insulation is in good condition.

Ordinarily, thrust collars furnished integral with sleeve-type bearings are not suitable for continuous thrust. It is extremely difficult to provide lubricant to these flat surfaces with assurance that they will not be subject to wiping of the babbitt. These collars are furnished merely to limit end float when operating uncoupled and during startup and shutdown. The motor has a magnetic self-centering force during normal operation and will try to center itself. Shaft slope and coupling action are factors that can cause thrust on bushing shoulders. In many cases, particularly large high-speed pump drives and the equivalent, it is necessary to limit coupling movement to less than the float in the motor bearings to insure against thrust damaging the motor bearings. If a coupling does generate thrusting either by the two halves pulling together or apart, any thrust imposed on the motor bearings is countered by an equal and opposite thrusting force imposed on bearings of the driven unit. For certain rolling mill operations it is necessary to furnish a mill-type thrust bearing arrangement with an extremely high collar and the thrusting surface so shimmed as to obtain a slight clearance from the collar. Sudden violent thrusting can then be imposed on the motor without damage. Such an arrangement is shown in Figure 4.

It may be of interest to know that where extremely large motors are to be installed in explosion-hazardous areas, it is now possible to furnish a machine with an inert gas atmosphere. There is, of course, no shaft seal required at the outboard end and there is a comparatively simple seal available for the coupling end of such a machine. This is a radial seal adjacent to the bearing bushing and mounted within the bearing capsule if it is a capsule-type machine. A low-pressure shaft-driven pump is utilized to supply oil to the seal. Being a radial-type seal, no particular difficulty is involved in its disassembly or reassembly. Entrained gas in oil carried through the seal into the motor is released and returned to the machine enclosure in an auxiliary sump before this oil returns to the main sump.

Large machines subject to constant reversing duty sometimes present problems in operation of oil rings. A light weight aluminum oil ring is available for such machines. This oil ring is relieved on its inner diameter to provide adequate unit loading where it contacts the shaft to prevent excessive slippage of the ring. Another arrangement that can be utilized is the provision of a viscosity pump. Such a pump consists of a collar mounted on the shaft and dipping into the oil well, with a suitable scraper arrangement at the high point of the collar to shunt oil into the bearing.

PROTECTIVE DEVICES

Various protective devices that are actuated by temperature are available for sleeve bearings. These include thermometers with or without alarm contacts. Such contacts can also be used to shut down equipment if that is preferred. Temperature-operated relays are also utilized. Both thermometers and relays are much more effective if mounted in the babbitt immediately under the journal where they are subject to maximum temperatures and can readily pick up a rapid rise in temperature. For flood lubricated machines, an oil pressure alarm can be very useful. The application of protective devices to anti-friction bearings is much less effective than with "fluid film" bearings, as the sensitive probe cannot be intimately located in the working area of the bearing.

INSPECTION AND INSTALLATION

Everyone wants to take some precautions when obtaining new equipment. Some will make a surface inspection of the unit as it is received and others will do more or less dismantling to make further inspection. It is important that motors and generators be kept dry and protected from dirt and other contaminants during storage, but it is also just as important that these same protective steps be maintained during installation and after installation is complete.

The use of anti-friction bearings requires very careful machining of parts and very precise assembly. Reassembly of an anti-friction bearing with its mounting requires comparable care in all respects.

Couplings of new machines should be carefully alined during installation. This applies when motors are coupled to driven equipment as well as to motor and generator sets. Sleeve bearings are not built to withstand alinement. This is particularly evident in the case of large two-pole (3600-rpm) motors, but it applies in a lesser degree to other motors. In some cases, it is desirable to make a hot operational check of coupling alinement and in all cases equipment should be doweled in place after alinement is satisfactorily attained.

It will always be necessary to check that the proper amount of lubricant is in the machine before putting the equipment into operation. Most well-established organizations consider it standard procedure to schedule the inspections of large equipment and this, of course, includes checking and replacing the lubricant. This schedule must be determined by those responsible for operations.

The use of large anti-friction bearings on the larger electric motors is somewhat limited. An illustration of such an installation is the drag generator. This very special application is tailor-made. Other fairly common applications of anti-friction bearings are vertical machines having a spherical roller bearing as the top-mounted thrust bearing with a lower ball guide bearing, or the use of stacked angular contact ball bearings with the bearings in a duplex arrangement, mounted two or three high, and suitable for speeds up to 3600 rpm.

The author has been discussing one of the most vital parts of any rotating electric machine. To produce iron and steel in the quantities our economy requires, the best possible designs and the best possible maintenance are required. These precautions are just as necessary when dealing with the electrical parts of the machines and with related electrical equipment.

Discussion

PRESENTED BY

B. B. WINER, Manager, D-C Mechanical Section, Westinghouse Electric Corp., East Pittsburgh, Pa.

R. M. DUNAISKI, Product Engineer, Large Motor and Generator Dept., General Electric Co., Schenectady, N. Y.

PETER R. WEIHSMANN, Engineering Dept., Elliott Co., Ridgway, Pa.

A. E. CICHELLI, Lubrication Engineer, Construction Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa.

WALTER T. SAVELAND, JR., Supervisory Engineer, Renewal Parts and Service Motor and Generator Dept., Power Equipment Div., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

B. B. Winer: The question of viscosity of lubricating oil is one that is often debated. On most applications, practically speaking, a fairly wide latitude can be allowed. However, it should be mentioned that in the case of a self-cooled bearing, a bearing that gets its oil by means of an oil ring, precautions should be taken before using a less viscous oil than the bearing manufacturer recommends.

At first glance it might appear that a lighter oil has certain advantages. For example, it might appear that if you use a lighter oil that the bearing temperatures would be reduced, and reducing the temperature would give more margin. But, actually, the use of a lighter oil could detract from the margin of bearing and is illustrated by Figure 5.

Let us first refer to the set of curves indicating heat dissipation. The intersection of these curves with the temperature co-ordinate represents the cooling air or ambient temperature. The curves illustrate that the heat dissipation for a bearing pedestal can be increased by increasing the difference between the ambient temperature and the operating temperature of the bearing. As the difference increases, more and more heat can be removed from the bearing pedestal.

Another set of curves on Figure 5 represent friction losses for a particular bearing and one will note that the losses are plotted for three different viscosities of oil—heavy, medium and light. As one would expect, at a specific bearing temperature, for example 50 C, a heavy oil results in greater bearing friction losses than a light viscosity oil.

The final operating temperature of the bearing would be the temperature where the heat dissipation and friction loss curves intersect. It is the temperature at which the amount of heat out is equal to the heat in.

Now let us compare two operating conditions. First consider an operating condition of 20 C ambient. With a 20 C ambient temperature for this particular bearing and a light oil, the final operating temperature would be 60 C. If, however, you use the heavy oil, the operating temperature would be 68 C, and, on the surface, it might appear that the lighter oil gives you lower temperatures and accordingly is more desirable. But note, however, a certain characteristic of these friction curves. As the operating temperature increases, the friction losses initially go down because of the decreased viscosity. There is a critical point, however, when the viscosity gets to a point where the oil film is so thin that a hydrodynamic oil film does not exist and the coefficient of friction and heat losses will increase very rapidly.

Now consider a bearing operating with a 45 C ambient. A bearing failure will occur with the light oil since the critical point of friction is reached and the heat dissipation and friction loss curves do not intersect. With the heavier oil, however, the two curves will intersect and the bearing operating temperature will be 83 C.

In addition, there are certain other advantages of a heavier viscosity oil. One important advantage is that an oil ring will deliver more oil with a high viscosity oil than a light oil. A second advantage is a thicker oil film is obtained with a high viscosity oil than a light oil. A thicker oil film will result in more operating margin.

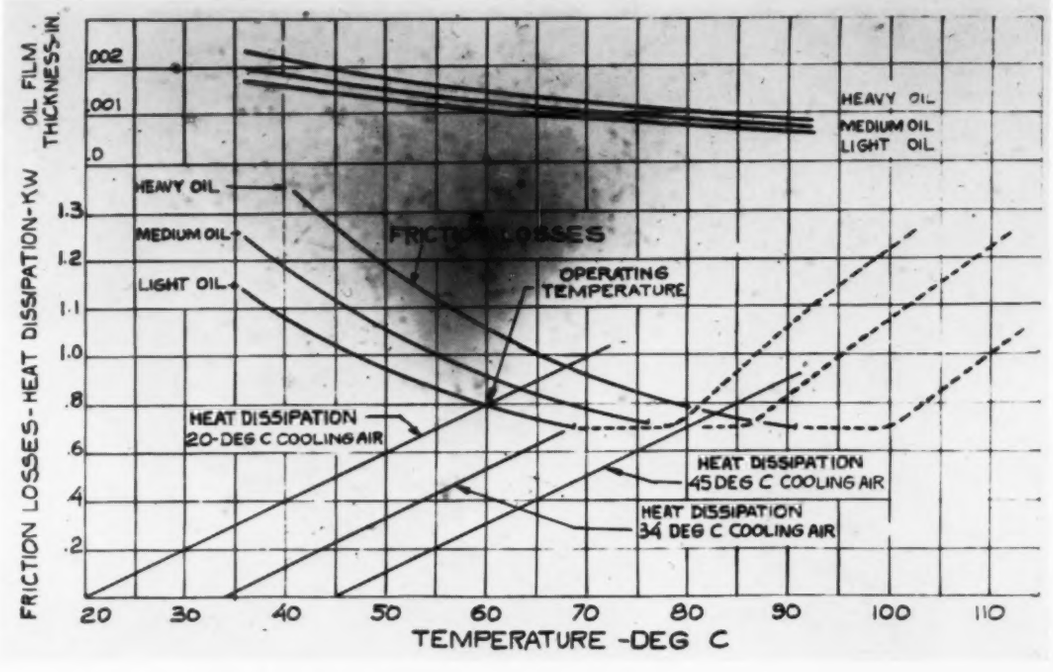


Figure 5 — In some cases the use of lighter oils may detract from operating performance.

Figure 6 — A fluorescent penetrant is being used to check bearing surface for flaws.

The following two figures illustrate interesting inspection techniques that have been employed in recent years. In Figure 6, the gentleman is checking for porosity and cracks in the babbitt of a large thrust bearing shoe. A fluorescent penetrating oil is applied to the surface of the babbitt and permitted to soak in for several minutes. The oil is then wiped off and a powder is applied which tends to draw the penetrating oil out of the babbitt. Then the surface of the babitt is examined with a black light having a wave length of approximately 3600 Angstroms. This black light clearly shows up the fluorescent oil and very minute cracks and porosity can be detected.

Figure 7 demonstrates an inspection technique for checking the bond between the babbitt and the steel or cast iron backing. An ultrasonic gage is employed which by means of ultrasonic waves evaluates the quality of the bond.

By means of techniques like these, we have been able to better determine the effect of various changes in our babbitting procedures and, as a result, have been able to produce better bearings.

One last comment we would like to make is that, generally speaking, electrical manufacturers are very conservative in their bearing applications. Large electrical machines have the common requirement that they operate for long periods of time with practically no wear or loss of efficiency. An important factor in the art of building reliable machines has been the progress in the design of bearings as a result of improved manufacturing methods and judicious application of theory. Most bearings for large electrical machines can be expected to give many, many years of trouble-free service.

R. M. Dunaiski: Mr. Saveland has presented a very descriptive talk on the various types of bearings, the necessary design criteria for satisfactory functioning and the cardinal requirements of proper maintenance for continued successful operation.

There are several questions which we would like to raise. These are:

1. Various oil viscosities are indicated for "high," "medium" and "low" speeds. What speeds are meant by "high," "medium" and "low?"

2. Mr. Saveland mentioned that the use of large anti-friction bearings on large electric motors is somewhat limited. The principal reason for this limitation is

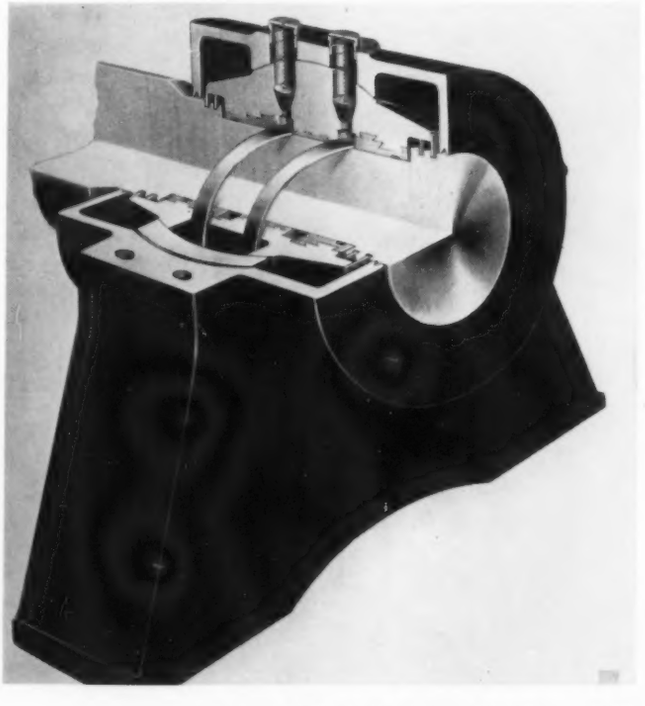
Figure 7 — Ultrasonic inspection may be used to check the bond between babbitt and steel.

undoubtedly the fact that the anti-friction bearing is normally thought of as a solid ring which must be mounted over the end of the shaft. However, finding more use in this country and originating in England, is the split roller bearing having split inner and outer races. The manufacturer of the bearing claims no performance limitation due to the split races. Would Mr. Saveland care to comment on this?

Most of the large horizontal machines have pedestal mounted, rather than end shield mounted bearings because of the large bearing reactions and thrusts involved. We generally classify these into two main types:

a. The industrial bearing, having a cast iron pedestal

Figure 8 — This pedestal and bearing were designed to eliminate oil leakage.



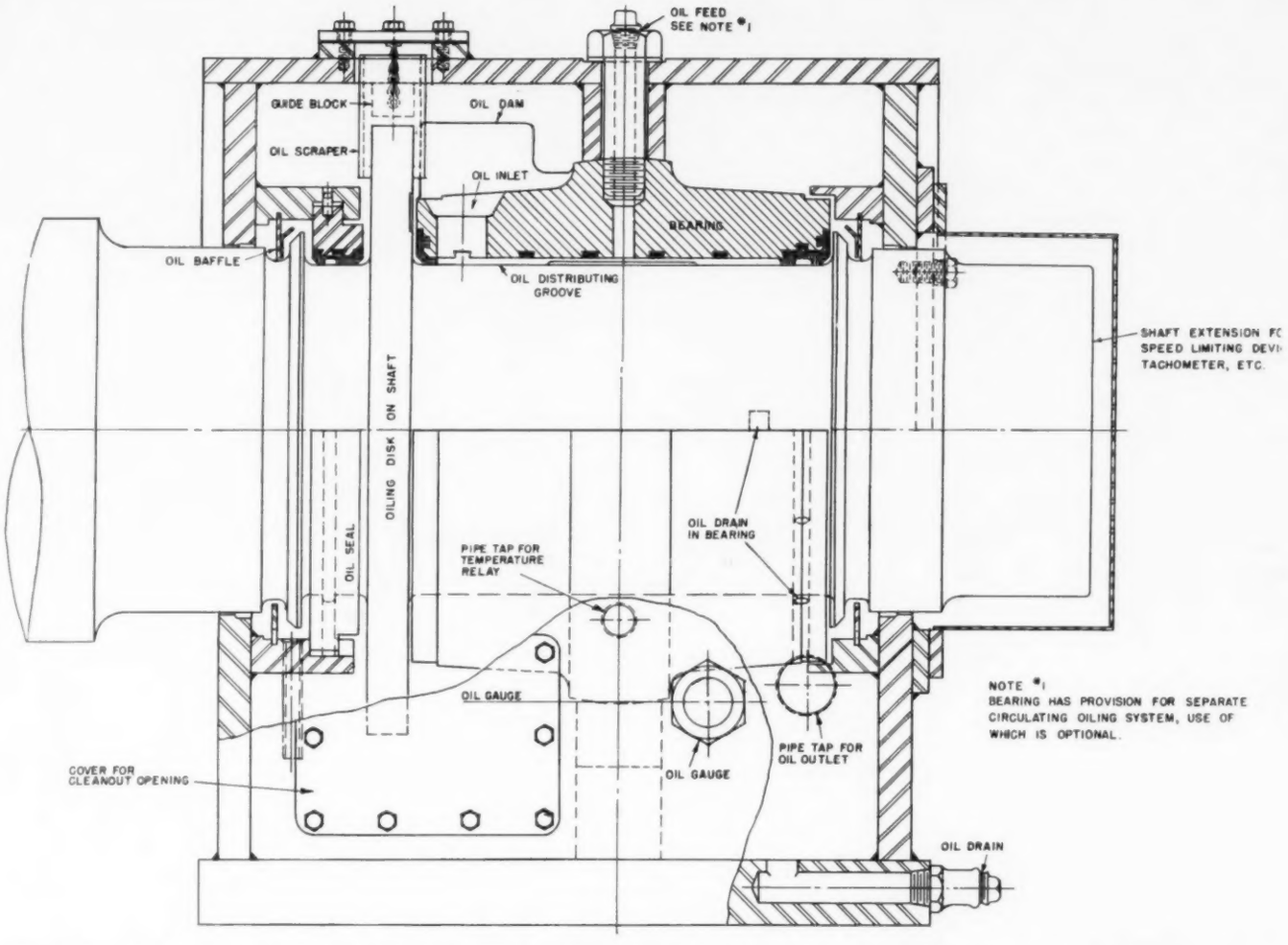


Figure 9 — This mill type fabricated pedestal has a spherical seat journal bearing and two-way thrust bearing.

construction with oil ring lubrication.

b. The metal rolling mill bearing, having fabricated steel pedestal with disk type lubrication.

Figure 8 is a cutaway view of the industrial bearing and pedestal arrangement. Note the spherical seat, the double shaft slinger and seal arrangement. We use this type of construction on uni-direction, impact free industrial machines, for example, a motor-generator set.

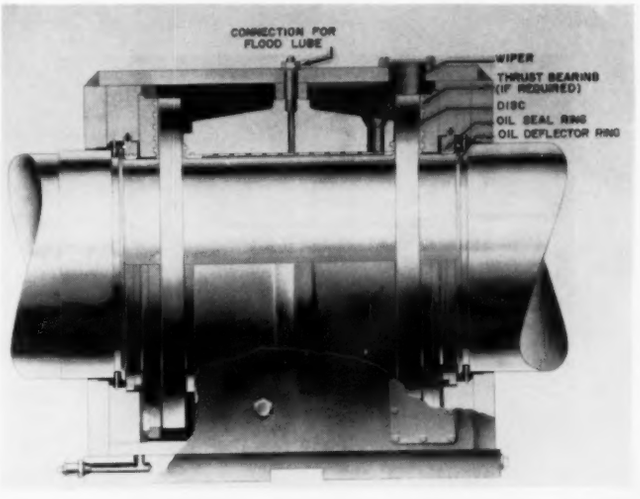
For metal rolling mill motors, where frequent starting and stopping, and in some cases reversing duty is experienced, a disk lubricated bearing (Figure 9) is used in preference to oil rings. The disk is formed either as an integral part of the shaft, or as a loose annular piece shrunk on the shaft. The ring serves as a viscous pump to carry oil to the top of the bearing where a scraper removes a quantity of oil and directs it into a channel where the oil is distributed through grooves over the top of the shaft. A babbitted oil seal is located adjacent to the ring to limit the amount of oil collected by an oil slinger. An oil baffle prevents any oil vapor from leaving the pedestal.

Figure 10 shows another variation of the disk bearing which is suitable for an oscillating thrust common with the application of universal joints, such as on a direct drive blooming mill. Double disks are forged integrally with the shaft and serve a dual purpose of thrust collars and viscous pumps. Since the disks are continuously running in oil, there is a heavy oil film between the stationary bearing and the runner which provides the necessary damping in a simple rugged structure.

In those instances where the thrust is large and continuous, as in a propeller shaft system of a ship, the solid stationary bearings can be made segmental and spring supported.

Another variation can be readily obtained by removing one of the thrust elements whereby a bearing suitable for thrust in only one direction is achieved. Single direction thrust bearings have found extensive

Figure 10 — This design is particularly applicable to direct drive blooming mills.



use in the protection of metal rolling motors from axial loads resulting from a torsional break of a roll neck or spindle shaft in the mill.

Peter R. Weihsmann: There are a few phases of Mr. Saveland's paper, particularly those dealing with lubricant selection and replacement, on which I wish to elaborate by presentation of data representing experience accumulated by my company.

Our company recommends lubricating oil selection for plain journal bearings on a basis similar to that presented by Mr. Saveland in Table I, differing principally, and in accordance with Mr. Winer's comments, in the recognition that somewhat heavier oils are required by ring-lubricated bearings than by pressure-lubricated units; this difference in viscosity requirements is based on the fact that ordinarily somewhat smaller oil flow is available for cooling of ring-lubricated bearings than in pressure systems, resulting in a higher temperature rise and a correspondingly larger viscosity decrease in the former. Moreover, we define our speed ranges for oil selection purposes as follows: up to 600 rpm—low speed; over 600 rpm to 1800 rpm—medium speed; over 1800 rpm to 3600 rmp—high speed. The resulting oil viscosity selection chart is shown in Table II.

TABLE II
Viscosity Selection Chart for Plain Bearings

Speed range, rpm	Pressure lubrication systems	Ring oiled bearings
	Oil viscosity in SSU at 100 F*	
Up to 600	300	420
Over 600 to 1800	150	300
Over 1800 to 3600	150	150

*** All viscosity values are nominal figures applicable to machines operating in a temperature range of 0 to 150 F. For units operating outside of this temperature range, corresponding adjustments in Table II may be required.**

It should be noted that the temperature range given in the footnote under Table II is intended to be used merely as a guide for lubricant selection, and not for checking of operating condition of particular bearings. Specifically an unusually high temperature rise, in a bearing that normally operates with a much smaller temperature increase, is an indication of trouble that should be investigated and corrected, even though the bearing temperature may be well within the limits applicable to Table II.

If high operating temperatures (above 180 F) are encountered under conditions that cannot be avoided, such as high ambient or lubricating oil supply temperatures, increasingly rapid oxidation rates will result, of an order that will normally become prohibitive at 220 F. In addition to actual temperature measurement, this condition can be confirmed by measurement of a marked viscosity increase after a relatively short service life of the oil, at which point that lubricant should be replaced.

Due to the widely varying speeds, bearing loads and oil capacities, and because of large differences in heat dissipation capacities of anti-friction bearing installations, proper oil viscosity for anti-friction bearings cannot ordinarily be selected on the same basis as that used for plain (sliding) bearings just referred to. We therefore generalize our recommendations for anti-friction bearings by stating them in the form of Table III.

TABLE III
Recommended Anti-friction Bearing Oil Viscosities

Type of bearing	Oil viscosity at operating temperature in SSU*
Spherical roller bearing	150
Cylindrical roller or ball bearing	110

*** Both viscosities are expressed as nominal values, and should be used as a guide only.**

In addition to specific viscosities applicable to plain and to anti-friction bearings, we also recommend a minimum viscosity index of 90, not only for the purpose of improving low temperature starting characteristics, but also to exercise indirect control over the quality of the lubricant.

It should be pointed out in this connection that departure from the recommended oil viscosity produces, to a limited extent at least, a self-compensating effect; thus, if heavier than recommended oil is used, a greater temperature rise will occur than if the proper oil had been employed. The raised temperature is the direct result of a higher coefficient of journal or bearing friction; this phenomenon is common to both anti-friction as well as plain journal bearings and, in the latter case, corresponds to an increase in the well-known ratio of ZN/P (Figure 11). As a result a decrease in viscosity will occur until thermal equilibrium is recovered at a temperature and viscosity somewhat higher than that of the recommended grade of oil. The opposite process will, of course, take place if too light an oil is used.

Many popular misconceptions exist concerning the need for lubricating oil replacement. We wish to point out that unless unusually high temperatures, high humidity or contaminating atmospheres exist, oil does not deteriorate in service. In many installations the same oil has been used for years without replacement. Centrifuges, mechanical and/or chemical filters are in common use to remove water or solid foreign matter that may have entered the oil system; chemical or "fuller's earth" filters should be used with care, however, since they tend to remove many of the important additives in the oil, such as rust oxidation inhibitors, defoaming agents, etc., as well as impurities.

Although we agree with the author that many additives present in commonly used lubricating oils do not offer any specific advantages, when used in mill motor lubrication, one well-known anti-friction bearing manufacturer has advocated the use of extreme pressure oils in a number of installations. Furthermore, in addition to the obvious benefits derived from the use of rust and oxidation inhibitors, we also point out that changing to oils containing defoaming agents has proved to be beneficial in several cases that have come to our attention. For a more thorough discussion of the subject of additives we refer to the paper "Additives in Steel Mill Lubricants" by M. S. Clark, 1956 Proceedings AISE.

Grease lubrication is frequently preferred in low-speed applications because of its simplicity. In the final analysis the decision of whether or not to use grease lubrication depends on the speed at which the

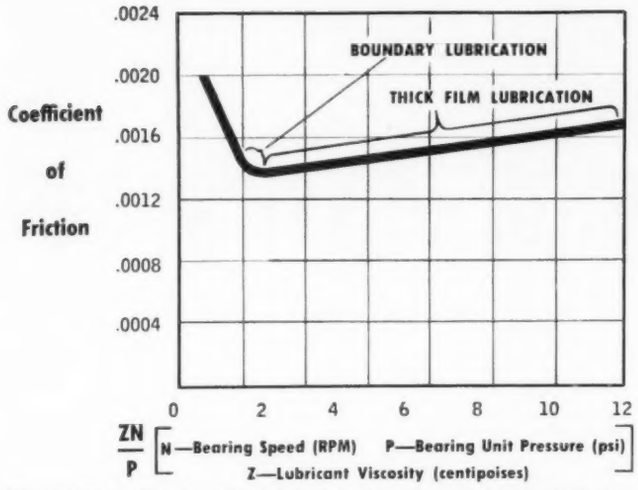


Figure 11 — Typical bearing friction curve shows dividing line between boundary and thick film lubrication.

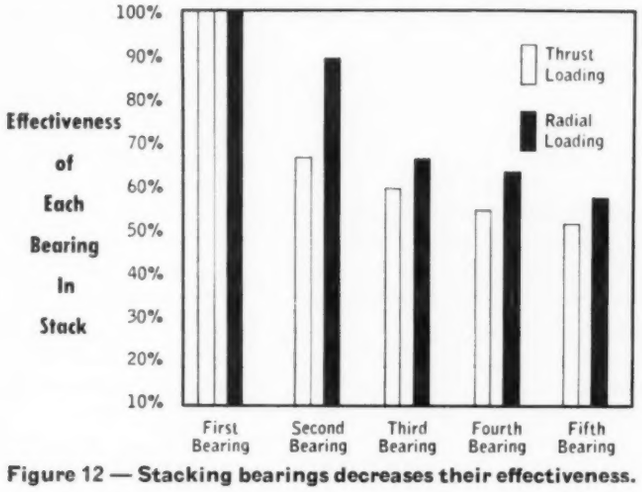


Figure 12 — Stacking bearings decreases their effectiveness.

bearing is operated, its size and the frequency with which grease can conveniently be added.

In addition to recommending a grease consistency within the range of 220 to 320 Worked Penetration Units (Ref.: ASTM D-217), we also state that the change from Unworked to Worked Penetration Number should not exceed 30 points; in this way some degree of control may be exercised over grease quality, in a manner comparable to the listing of a minimum viscosity index for oils, as previously mentioned.

It should be pointed out, however, that it is very difficult to write product quality into lubricant specifications and that neither a definite maximum change in penetration number nor a minimum viscosity index will in themselves, guarantee satisfactory lubricants, but that such specifications merely indirectly affect quality; much weight should therefore be attached to the integrity of the lubricant supplier, his understanding of the application and past experience.

Finally Mr. Saveland mentions the use of "stacked," angular contact, ball bearings; we wish to express our opinion to the effect that, due to the impossibility of perfect alignment of bearings, assembled in this manner, the effectiveness of each bearing added to a "stack" decreases rapidly, as can be seen from the bar chart shown in Figure 12. We contend that use of roller, or sliding bearings provides a more effective means of increasing the load carrying capacity over that of "stacked" bearings, within the space limitations of a given installation, and for a specified service life.

A. E. Cichelli: Several years ago, there was an epidemic of motor bearing failures in our 68-in. strip mill which had been previously operating seven or eight years without a mishap. We did not pay much attention to the first bearing failure, but when the failures spread to several more, a real study was undertaken to resolve the problem.

One significant point was that in almost every instance the bearing failure occurred after a roll change but not necessarily on the mill being changed. The oil system was like every other system we ever had. The filter in particular had a 90-mesh monel screen and was devoid of dirt particles. In our computations we learned that on starting up, the film thickness was very, very small, smaller than particles found in the bearing wells. These contaminants never left the bearing well; they just settled to the bottom or were drawn up by the ring and then carried through the wedge. Since the particle sizes measured considerably larger than the film thickness, we concluded that, during the years of operation these larger particles actually abraded away the 60 degree bearing arc that we had originally until it reached an included angle of 140 degrees. With that angle, the temperature rise of the oil traversing under the journal was much greater and since the speed was so low at roll change, the oil film became too thin to carry the load, causing the bearing to fail.

As a result of that experience, we have, in that mill and others, set up an inspection program of our bearing wells. Secondly, we introduced much finer filtration ahead of the bearings.

Walter T. Saveland, Jr.: Mr. Dunaiski asked a question as to whether the breakdown of this chart I presented was for medium, high and low speeds versus viscosity. We prefer not to break such things down too much. We think that when you are getting into large machines that you are getting to the point where you have to be a little bit careful. People doing the operating of the equipment have to know what they are doing themselves, as well as being told what to do. Of course there is a gradual step from general purpose ratings through the bigger machines up to the biggest. He also asks about the split anti-friction bearings. That bearing has possibilities. It is not used very much. It has been available for quite a long time. I am surprised nobody thought to mention one little difficulty we do have with the anti-friction bearing, and that is that there is no warning given before failure. That is just as much applicable to this split one.

As regards the dual recommendation by Mr. Weihsmann in viscosities for ring oiled bearings versus flood-lubricated bearings, I would say that if you have a large flow of oil, yes, there will be a difference. Some people furnish their machines with a relatively small amount of oil supplementing, or actually mainly taking the oil supply through the oil rings; then there need not be this change in viscosity from one system to another.

For the anti-friction bearing lubricant chart, that is a good chart; the only trouble is that you still have to tell the man what grade of oil to use, because he is going to be pretty well lost by the time he makes two or three tests to get up to operating temperatures.

On the stacked angular contact roller bearings, I agree very heartily; in fact if you get beyond three bearings you are really putting them in line. ▲

Noise—A Problem of Physical and

by Richard D. Lemmerman,
Manager,
and Richard R. Audette,
Assistant Chief Engineer,
Industrial Sound Control Dept.
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Baltimore, Md.

. . . . noise is a two-dimentional problem which depends on both intensity and frequency . . . . by comparing established criteria for human tolerances and reaction with an analysis of the noise problem, it is possible to determine how much noise reduction is required . . . .

THE problem in industrial noise, which has arisen seemingly only recently to plague both management and the safety engineering personnel, is in reality not a new one. Rather, instead, the cognizance of noise as a major industrial problem is new. Increased economic pressures through the new proximity of residential areas in the case of the residential noise problem, and the results of ear damage compensation claims, together with union demands for improved working environments, have spurred more recent interest in the noise problem.

The aircraft engine industry has been plagued with serious noise problems for two decades and other industries with increased interest in the noise problem are beginning to move along the same path followed by aircraft.

Similarly, the basic engineering approaches to industrial noise problems are relatively new, developed by the demands of the aviation industry. Instrumentation and measurement techniques, together with basic information as to how people react to noise environmentally, have made substantial strides in the last few years, thus allowing noise control to move from the realm of theoretical physics to that of a true engineering science.

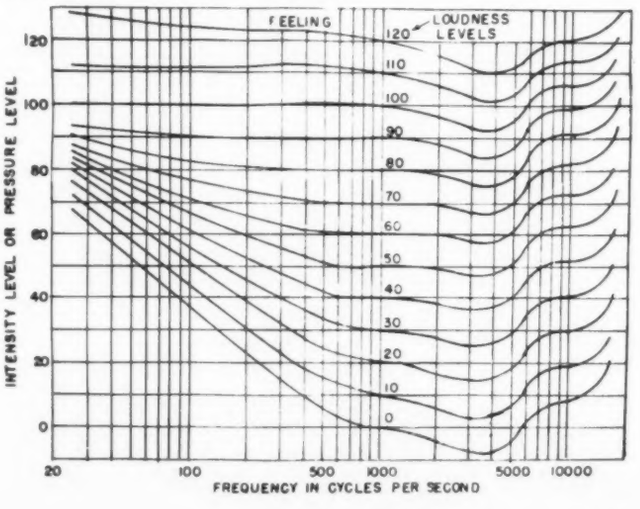
This paper examines noise in the framework of its effect upon people and discusses several solutions to industrial noise problems through the analysis of typical case histories of industrial noise problems.

NOISE—ITS CHARACTER AND PARAMETERS

In order to apply engineering principles to any noise problem it is necessary to describe the character of noise completely in terms of all its parameters. The first of the two major parameters of sound is intensity or amplitude measured as the sound pressure level recorded in terms of decibels. The other major dimension of sound is that of frequency or pitch. Although both of these dimensions are of equal importance in describing a noise source, in many cases only an integration of the amplitude or the over-all sound pressure level is considered. It is as impossible to adequately handle a noise problem using only the parameter of sound pressure level as it would be to design a bridge in only two dimensions. In the consideration of any noise problem it is necessary to relate the noise source to its effect on human beings. Since this effect is primarily through the sensing organ of the ear, we must consider the effect of both these major parameters upon the ear.

The response of the ear to a given sound pressure level varies substantially with frequency, as shown on Figure 1. From these Fletcher-Munson curves of equal loudness we can see that the average ear considers a 70-decibel sound at 1000 cycles considerably louder than the same sound of 70 decibels produced at 50 cycles per sec. Thus, it is of the utmost necessity to consider both the major dimensions of sound, intensity and frequency, in the solution of noise problems.

Figure 1 — The response of the ear to given sound pressure levels varies with the frequency.



Human Engineering

The frequency parameter of sound can be measured either by pure tone analysis, or more conveniently by dividing the audio spectrum up into bands of frequency range, such as octave bands, half octave bands, third octave bands, etc. It has only been in recent years that spectrum analysis of many industrial noises has been available for noise control design. Most industrial noises are very broad in character, that is, some acoustical energy is radiated over the full audio range from 20 to 20,000 cycles.

There are other minor parameters besides intensity and frequency to which the human ear is sensitive. Very little is known quantitatively concerning these secondary effects, but they nevertheless influence engineering design in industrial noise problems. The rate of rise and fall of the frequency spectrum seems to be important. Human beings are happier in continuous noise spectra of a broad band character than in the environment of a sharp peak spectrum, almost pure tone in character. Similarly, the periodicity of the sound is of some importance. Continuous noise is much less annoying than interrupted noise or impact type noise. These secondary parameters should be used to shade the design criteria set forth later in the paper, up or down by several decibels. See WADC Technical Report 52-204 "Handbook of Acoustic Noise Control," Volume II, "Noise and Man."

NOISE SOURCES

As a general rule all machinery from a typewriter to a turbojet engine put out approximately 0.7 of 1 per cent of their total energy into acoustic energy. Figure 2 shows the spectrum of several familiar industrial noise sources; the low frequency hum of a transformer, low and middle frequency noise from a fan, and the high frequency squeal of a grinding or milling machine. It should be noted that although all of these noises have major peaks in their frequency spectrum, they are all broad band in character and radiate some noise over the full audio spectrum.

CRITERION OF HUMAN TOLERANCE

There are three major effects of noise on human beings, depending upon the frequency character of the noise and its intensity. At very high intensities the human ear will suffer physical damage. This may be as serious as outright rupture of the ear drum at extremely high intensities, or at somewhat lower intensities decreased ear sensitivity or hearing loss. The noise at lower intensities may interfere with communication and mental concentration. The noise may be psycho-

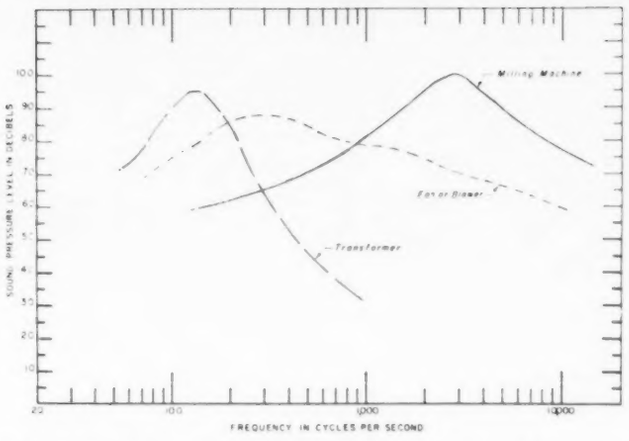
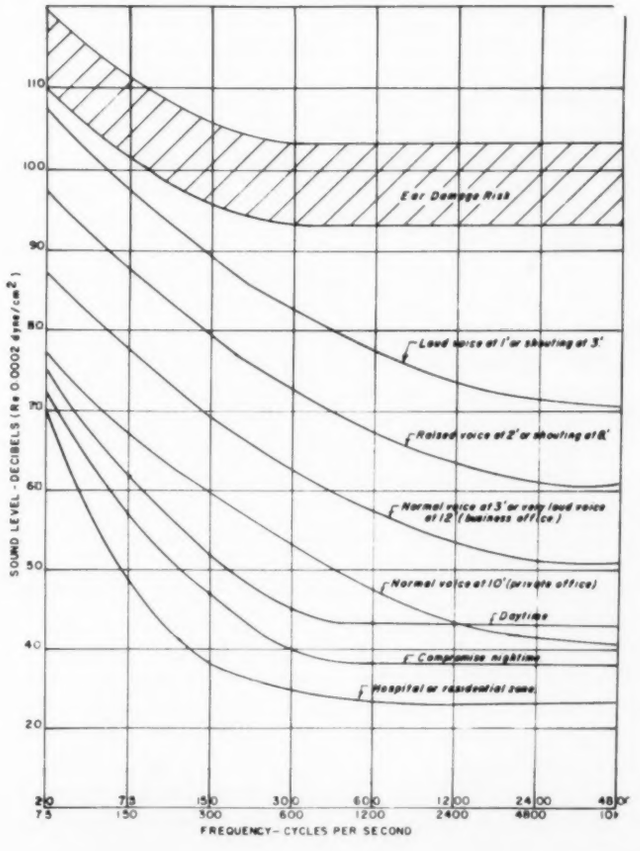


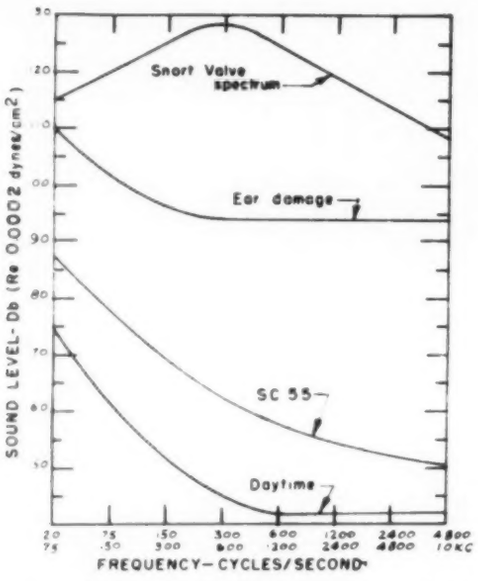
Figure 2 — Familiar industrial noises have various spectrums.

logically annoying to a residential home owner, actually interferring with his sleep, if the noise is produced during sleeping hours. Figure 3 represents a series of criteria curves developed at the Psychoacoustics Laboratory at Harvard by Dr. Rosenblith's group and the Acoustics Laboratory at MIT. These are not necessarily the ultimate rigorous criteria of human tolerance of noise, but represent a basis for engineering design at the present state of knowledge in the field. Refinements in these criteria curves are to be expected as our background of knowledge increases.

Because of the broad and variable sensitivity from individual to individual, for broad band noise the upper curve must be considered an ear damage risk curve above which, under continual exposure, ear dam-

Figure 3 — Chart compares various noises with requirements for ear damage.


Ear Damage Risk
Loud voice at 1' or shouting at 3'
Raised voice at 2' or shouting at 8'
Normal voice at 3' or very loud voice at 12' (business office)
Normal voice at 10' (private office)
Daytime
Compromise nighttime
Hospital or residential zone
SOUND LEVEL - DECIBELS (Re 0.0002 dyne/cm²)
FREQUENCY - CYCLES PER SECOND



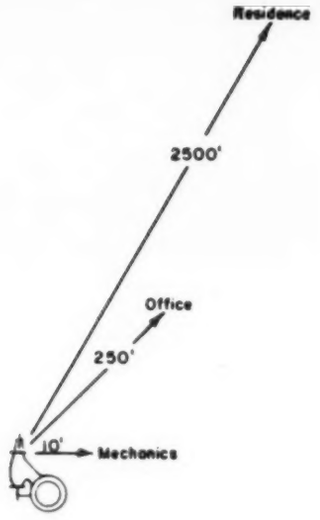


Figure 4 — Chart illustrates noise problem created by snort valve.

age is almost completely assured, below which there is a high probability of no ear damage resulting. If the noise characteristic is pure tune rather than broad band, the lower ear damage risk curve must be used, for pure tone noises are much more damaging to the human ear. The other curves of Figure 3 in descending order show noise levels for various conditions which are often met in industrial noise problems. The first and second curves are levels which are frequently found in manufacturing areas, the third, business office noise level and the fourth, private offices. The three bottom curves, the residential criteria curves, are useful in determining the effect of noise of an industrial plant upon nearby residential neighbors and predicting whether this noise will cause complaints or possible legal action.

PROBLEM APPROACH

With the background of source and criteria a basic engineering approach to the problem can be followed. The source noise level is determined at the complaint area, whether this be a machine operator's ears, a foreman's desk, or a residential home owner's bedroom. The source spectrum at this complaint area is then compared to a typical criterion for this environment and the difference between the two curves is the noise, frequency by frequency, which must be removed or attenuated by some means to solve the problem.

There are three examples below in the form of case histories, together with engineering data and their solutions. It is to be noted that the required noise reduction is considerable and requires rigorous, bold approaches for proper solution. Most industrial noise problems are acute, requiring large attenuations or reductions in noise for their solution. For this reason removal of the noise by area type absorption, such as acoustical ceiling tile, space absorbers, hanging baffles, etc., is not normally applicable to the acute problem. Area absorption will reduce reflected energy but does little or nothing to the noise energy coming directly from the machine to the operator or complainant. Noise reductions in industrial spaces of eight to ten decibels coupled with the reduction of reverberation in the room can be expected from this type of treatment, and while this is of extreme value in an area such as a drafting room or office space, most acute industrial noise problems cannot be economically solved through this medium. In order to acquire the large reductions in noise necessary to fulfill the design analysis, it is necessary to provide shielding, as well as absorption, for either the machine or the people involved, or redesign the machine so as to reduce the noise at its source.

In many cases ear damage risk can be reduced by wearing ear plugs or muffs, several excellent varieties of which are on the market. However, it is extremely difficult to enforce the wearing of ear protection devices and this is seldom a satisfactory solution to the problem of industrial noise, because of difficult enforcement and the limitations that such devices place on communication.

DESIGN EXAMPLES

Following are briefly described three examples of industrial noise problems and their typical engineering solutions. Figure 4 shows the composite analysis for a snort valve installation. The upper curve represents the snort valve sound pressure level measured at a distance of 10 ft. There are three critical areas involved in this design. One is represented by the second curve, an ear damage risk criterion for the operations and mechanics nearby to the snort valve; two, a possible complaint area in the form of office spaces 250 ft from the area whose criterion of tolerance is shown as the third curve. The bottom curve represents the residential sleep criterion which should be met at the residential area distance of 2500 ft. The distance between the source curve at the top and each of these criterion curves is the amount of attenuation which must be provided by the combination of distance and exterior sound treatment to meet the criterion level design goals established by the usage of the critical areas. Any one of these three areas may limit the design and thus require over-design for the other two. A typical solution to this problem may be seen in Figure 5, a system of silencing the valve discharge, allowing the free passage of air and gases, but reducing the passage of

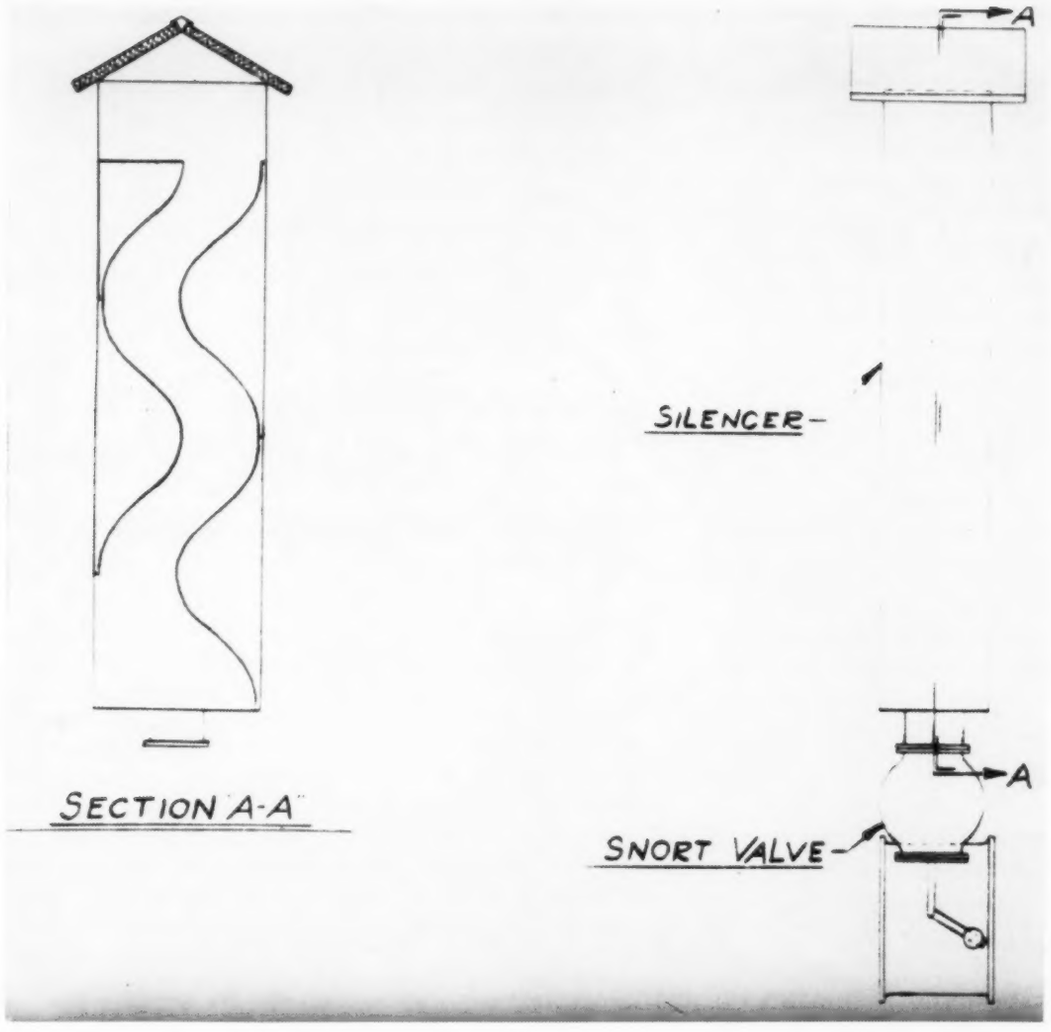


Figure 5 — Schematic shows silencer developed for valve discharge.

noise to meet the required limitations.

Example two is a planishing hammer room where sheet metal stampings are being continually hammered and shaped. The spectrum level in the room before treatment is shown in Figure 6, together with the criterion for ear damage risk. One of the basic problems in the planishing hammer operation noise control is the factor of exposure time. Under isolated conditions, the man operating the planishing hammer would be exposed to the noise of his own hammer only approximately 20 per cent of his total time during the day. However, in an open room containing many hammers, the operator is continually exposed to intense noise levels from his own hammer and from those about him, so that the noise level at the operator's ears is only raised slightly when his own hammer is in operation. Also, under these circumstances it is impossible for supervisory personnel to converse with the operators or with each other in the area adjoining the planishing hammers.

Curve A in the upper hand graph is the noise level at the operators' ears and throughout the entire room before treatment. Curves B and C represent ear damage risk criteria and speech communication criteria acceptable for the supervisory personnel in the area adjoining the hammers. Treatment of this noise problem could be most economically accomplished by the erection of sound retardment barriers between individual hammers, roofed over so as to prevent the transmission of as much noise as possible and thus forming a booth in which each hammer is operated. The fronts of these booths had to be left open in order to provide adequate access for material and personnel to the hammer itself. The results of this type of treatment can be seen on the lower graph of Figure 6. Curve A represents the initial source level, Curve B, the noise level at the operator's ears after treatment, Curve C, the noise level in the area adjoining the hammers, and Curve D, the noise level from booth to booth, the noise level in an adjoining booth with a single hammer in operation. Thus, each individual operator was given relief during the time in which his hammer was not in use and his ears substantial recovery time. At the same time, the noise level in the area frequented by supervisory personnel was reduced to that commensurate with adequate communication. Figure 7 shows the treated area.

The third example of an industrial noise problem, Figure 8, is that of a paper mill where the noise of the mill rollers, coupled with the intense squeal of the paper maker's couch, or vacuum box drum, produces a noise spectrum well above the ear damage risk criteria. A papermaker's couch is a large rotating drum constructed of perforated steel over which the pulp slurry is dried by sucking air and water into the drum through the holes. The paper mill itself is a completely automatic operation needing only periodic, but short, duration maintenance and adjustment by the opera-

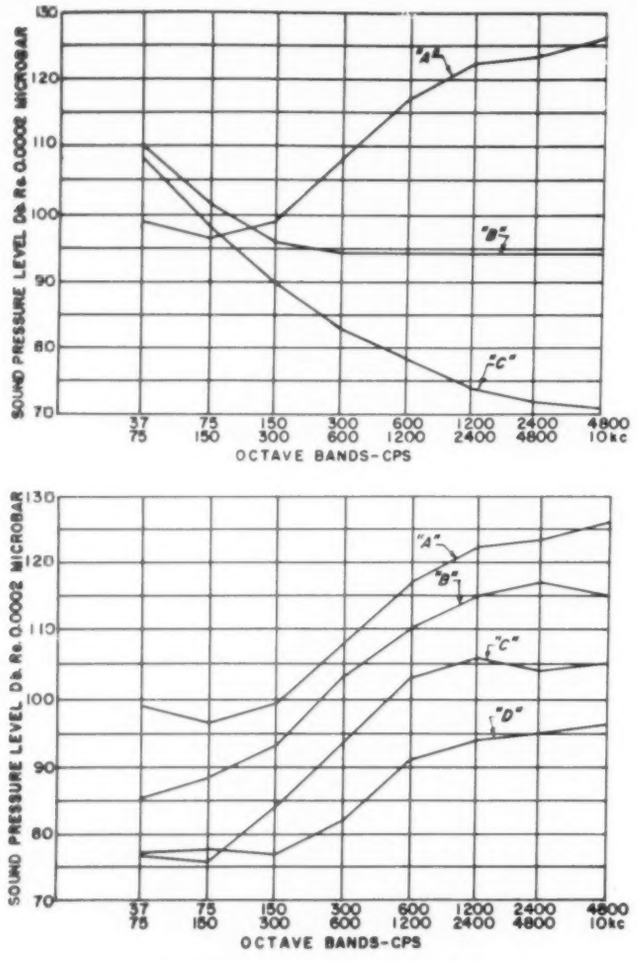
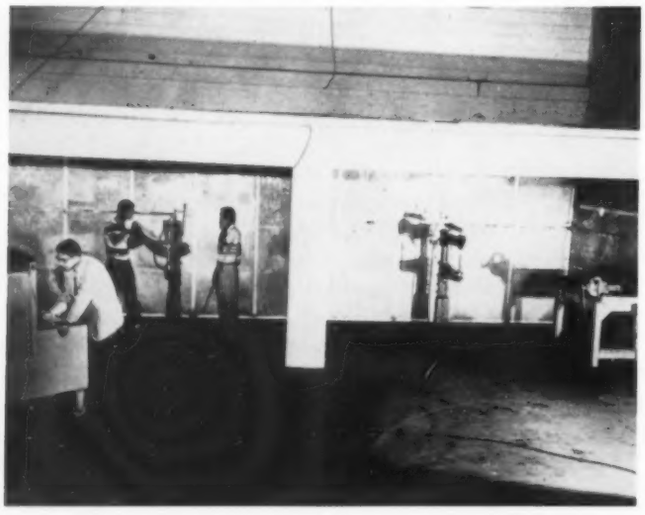


Figure 6 — Hammer room noise may cause problems. Effect of various solutions are shown by the graphs.

tors. Because of the size of the equipment, complete or partial enclosure of the noise source does not provide the most economical solution to the problem. Instead, it is far more economical to provide a single or a series of soundproof areas into which the operators can withdraw, viewing the machines through sound reduction windows.

The operating personnel when working in the direct vicinity of the machine can be adequately protected

Figure 7 — Isolation of personnel may be one solution to the noise problem.



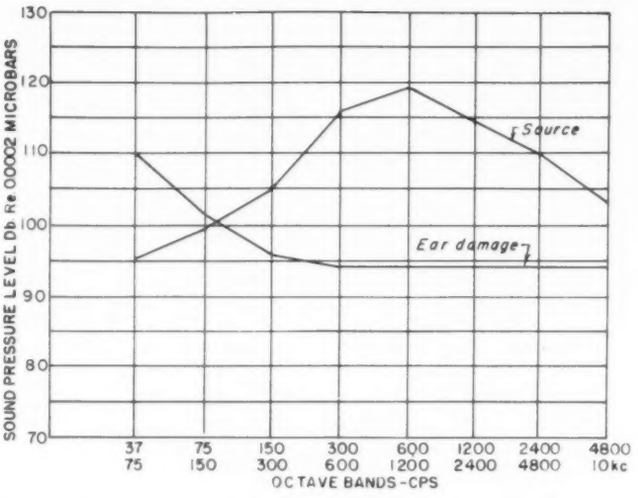


Figure 8 — Paper mill noise gives problems which are difficult to solve.

by means of commercial ear defenders and withdraw to the relatively quiet area provided for the longer observational portion of their work. This reduction of exposure time is extremely important in the case of ear damage to allow the ears recovery time. However, little is known about the quantitive effect of this recovery time.

Another possible solution to the paper mill noise problem lies in the redesign of the basic noise generator, the paper making couch. This has recently been done experimentally by Dr. Thiessen of the National Research Council of Canada by changing the size and arrangement of the perforations to reduce the noise generated. This work represents a major step in the solution of the paper mill noise problem.

SUMMARY

In summary, a basic engineering approach to industrial noise problems can be followed by first analyzing the full audio spectrum of the noise source. By applying recently established criteria for human tolerance and reaction to noise, the amount of noise reduction at any given frequency can be ascertained. If this noise reduction is substantially small, say five to eight decibels in the mid-frequency speech interference range, a possible solution can be looked for in terms of area absorption by introducing absorptive surfaces in the form of acoustical ceiling tile, hanging baffles, or other space absorbers. However, if the required reduction is substantially greater than that called for above, as is the case in most industrial noise problems, one of the three following approaches must be followed:

1. Machinery redesign.
2. Partial or complete enclosure of the source.
3. Partial or complete enclosure of the people involved.

Each problem must be analyzed individually and a balance determined involving the economic factors of each of the three design approaches to determine the most probable and best solution to the specific problem involved.

Discussion

PRESENTED BY

FRED E. TUCKER, Industrial Hygienist, Weirton Steel Co., Div. of National Steel Corp., Weirton, W. Va.

RICHARD D. LEMMERMAN, Manager, Industrial Sound Control Dept., Koppers Co. Inc., Baltimore, Md.

M. E. TALAAT, Research and Development Engineer, Elliott Co., Ridgway, Pa.

EUGENE SMITH, Research Administrator, Lukens Steel Co., Coatesville, Pa.

Fred E. Tucker: Many mistakes have been made in noise control due to the lack of understanding of the parameters of noise. This presentation by Mr. Lemmerman and Mr. Audette should clarify some of the misconceptions currently present in the application of engineering principles to noise control problems.

The authors have effectively outlined the questions concerning the parameters of noise which you must ask prior to your consideration of a particular noise problem. At our Weirton plant, we are actively engaged in a study of the noise characteristics of all plant operations. This study is going into its third year and we are now equipped to answer questions from our engineering department concerning these parameters whenever the need for this information may arise.

I had the experience of visiting one plant where their noise control program consisted of "brainstorming" sessions. These sessions were attended by employees closely associated with the particular noise problem under consideration, but with little engineering background. The result was that many ideas were tried at considerable expense of time and money which netted little, if any, return in noise reduction. I was told of one instance where the noise level was actually increased by the improper use of acoustical treatment. This problem is one which requires a true basic engineering approach as outlined by the authors in order to gain the maximum value in noise reduction with the minimum capital expenditure.

Of particular interest was the authors' example two, under "design examples," which dealt with noise reduction in a planishing hammer room. Heavy industry is constantly moving toward remote control of its equipment. Strip mills, cleaning lines, continuous annealing lines, etc., are all being operated from control panels which confine the operator to a fixed location. The presently accepted concept of noise reduction, "control the noise at its source," does not apply in this situation. Redesign of such large pieces of equipment in order to reduce the noise at its source would be impractical from the standpoint of cost. The only avenue of control remaining is to confine the people involved. The results obtained by the authors with an open face booth are very encouraging.

Most operators of heavy equipment installations are for all practical purposes immobile, but there are normally certain details of operation which require him to leave the control center for brief periods of time. The open face enclosures described by the authors allows complete mobility while at the same time provides sufficient attenuation to reduce the noise levels in his working zone below the damage risk criteria. An open face booth also eliminates the necessity for installing air conditioning as is the case in a complete enclosure.

I believe the hearing damage risk criteria presented by the authors is slightly high by our proposed standards. The most recent suggested hearing damage risk criteria as proposed by the Subcommittee on Noise in Industry of the Committee on Conservation of Hearing of the American Academy of Ophthalmology and Otolaryngology are as follows: "If the sound energy of the noise is distributed more or less evenly throughout the eight octave bands, and if a person is to be exposed to this noise regularly for many hours a day, five days a week, for many years, then: if the noise in either the 300–600 cycle per sec band or the 600–1200 cycle per sec band is 85 decibels, the initiation of noise exposure control and tests of hearing is advisable. The more the octave band levels exceed 85 decibels the more urgent is the need for hearing conservation." These recommendations are based on actual industrial experience and the choice of frequency levels is keyed to hearing losses which interfere with the understanding of speech. It has been found that noise-induced hearing losses occur at frequencies above those that characterize the recorded exposure levels. For this reason the frequencies indicated in the suggested criteria are slightly lower than the speech frequencies of from 500 to 2000 cycles per sec.

We have adopted the criteria of the Subcommittee on Noise in Industry due to their extensive background in industrial noise control. I would appreciate hearing the authors' comments on the comparison of these two criteria.

Richard D. Lemmerman: We are familiar with the work of the American Academy of Ophthalmology and Otolaryngology and this points up the state of, not the acoustical application art, but certainly the basic problem that we are dealing with human beings.

There is certainly some evidence in the case of the ear-damage risk curve that we have presented here. In the case of weak ears and in the case of certain types of noise, it is somewhat optimistic. I do not believe, however, that the statement of merely picking a single number at 300 and 600 cycles will be adequate. The statement was made that if the spectrum was broad in character we can do this, and I would agree with them. But many, many noise problems, such as milling machines where we have in the 300- and 600-cycle band relatively low noise levels—maybe 80 decibels—but at 2000 or 3000 cycles, we are putting out 125 decibels. This is the basic problem.

The Air Force has recently come out with a report which follows the American Academy recommendation quite well, but it also attempts to integrate a time factor into the picture. That is, they are taking the same approach that the radiation hazard people are taking, and that is total time exposure, as well as the total amount of energy in each frequency band. I think this points up that we have still a great deal to learn about this particular phase of damage to people's ears.

M. E. Talaat: The authors have summarized the noise problem both from the psychological as well as the industrial point of view. We would like to discuss some of the aspects of the new cognizance of noise as a major industrial problem that must be met by both machinery user and manufacturer. In particular, we would like to

discuss some of the problems of the noise produced by electric rotating machines.

The user of electric rotating machines could be facing any or all of the following problems:

1. He could be concerned with strong complaints from labor about cases of hearing loss or impairment due to men working in close proximity of very noisy machines in an already existing installation.

2. He could be worried about poor speech intelligibility and communication at a noisy installation. Excessive noise can mask safety warnings to his operators at hazardous moments.

3. He could be desirous of providing his employees inside the plant with reasonably quiet offices which would insure their comfort and increase their efficiency.

4. He could be concerned with complaints coming from nearby residential areas about noise emanating from his plants.

In order to handle intelligently the noise problem of an already existing installation, the user must first be able to obtain, at the critical areas in question, certain noise data which he can compare with the psycho-acoustical criteria for the three most unwanted aspects of noise, namely, annoyance, speech interference and deafness risk. From such a comparison he can determine the amount by which the noise must be reduced to arrive at an acceptable level. He can then decide upon the most economical curative measures to achieve that result.

On the other hand, to acoustically engineer an intended future installation the user will need, for each machine to be used in that installation, the noise rating which will enable him to do the following:

1. Predict the sound pressure level at any point in the noise field of a machine or combination of machines whether the location is outdoors or in an enclosure.

2. Determine, by comparing the predicted sound pressure levels with the psycho-acoustical criteria, whether it will be necessary to purchase machines having lower noise ratings or whether curative measures can be economically made at the installation site.

Needless to say, one important aspect which should be considered when facing these problems is that of obtaining by measurement noise data which would be compatible with the psycho-acoustic criteria with which the data must ultimately be compared. The noise data should also be such that it can be used to evaluate the sound pressure level at any distance from the source and under any evironmental conditions.

The American Institute of Electrical Engineers in recognition of these problems has embarked on a noise evaluation study to arrive at a new noise test code. This code will give uniform procedures for testing electric rotating machines in order to obtain the noise data which would serve the purposes of both user and manufacturer of electric rotating machines.

The other important aspect of the problem which I would like to bring out is that careful consideration should be given during the planning stage as to whether quiet operating machines should be purchased or whether curative measures for noise reduction can be applied after the installation is completed.

Examples of some curative measures for noise reduction at the installations site have been covered in the paper under discussion. It should be pointed out, however, that in some cases the cost of noise reduction after a machine is already installed can be out of all proportion to the cost of the machine itself. To cite an example, one user had to spend $3000 for an enclosure to quiet a 250-hp, 3600-rpm dripproof motor at the instal'ation site. This was approximately 100 per cent of the cost of the motor. Compared with this an increase of 10 to 30 per cent in the price of the motor would have furnished this user with a quiet operating motor directly from the manufacturer. This would have been much more economical in the first place, not to mention the added ease of inspection and lubrication of such a motor.

The desire on the part of many users to have a quiet operating motor particularly in the large horsepower high-speed ratings has given the incentive to some manufacturers of electric rotating machines to approach the problem of noise reduction at the source, namely, the development of a quiet motor.

The new quiet motor, developed by our company is a typical solution to this problem of industrial noise reduction at the source. The solution was accomplished by first identifying the predominant pure tones or frequency bands generated by the motor and then modifying the design and construction of the motor to eliminate or considerably reduce the levels of these noise components.

Thus, careful consideration should be given to the purchase of quiet machines for any intended installation. It may be more economical than post-installation methods of noise reduction.

In conclusion, one can say that noise is today considered a major industrial problem and it requires serious effort on the part of both manufacturer and user to reduce its ill effects by all the means available to them. The resulting increased human efficiency, safety and comfort are well worth the efforts expended.

Eugene Smith: Referring to Figure 2, can you modify the noise level by superimposing a second noise of a different spectrum?

Richard D. Lemmerman: Can we, given a specific frequency, superimpose out of phase with that spectrum, a comparable spectrum completely out of phase, and cancel the noise?

This is sort of like the fountain of youth. It has been done in certain specific cases. Some work has been done in reducing transformer noise by adding an equal noise so phased as to cancel out the transformer noise A loudspeaker placed as close as possible to the transformer in the open air is made to emit a harmonic range of tones, each one of which is adjusted in magnitude and phase so as to cancel, at the location where quiet is desired—the corresponding tone of the same frequency in the noise from the transformer. A power amplifier supplying the loudspeaker is fed from a suitable source of harmonics, with amplitude and phase adjustment for each. The harmonics can be obtained from the live voltage through a rectifier or from a vibration pickup attached to the transformer tank, suitable filter being included to pick out each harmonic for individual control. At a point, say 100 ft away from a transformer, it is possible to effect complete cancellation of any one harmonic for a short time; but, attenuation of 20 db are more representative. Over an angle of 35 degrees the average attenuation of the noise is somewhat less, and may be only six db. Increases in noise are inevitable in other directions unless directional loudspeakers are

used. The method does not appear to be suitable for cases where a reduction of noise is desired in all directions or, indeed, in anything more than a very restricted cone.

The problem in other industrial applications is much more complex. The noise produced by machines are made up of a composite of frequencies and a composite of phases both of which are constantly changing. In addition, you have around this machine other machines which disperse, diffuse and reflect the sound field. In addition you have walls which do the same thing, also confusing the picture still further. Theoretically, it is possible. However, at this stage of the science it is not practical.

Eugene Smith: On Figure 1 where the intensity level is shown, what is the significance of the values below-zero?

Richard D. Lemmerman: The decibel notation is strictly a matter of convenience. The human ear has a tremendous range. You can hear from zero decibels—it is actually the absolute pressure in dynes per square centimeter relative to 0.0002 dynes per square centimeter. The ear can hear very small pressure and it can withstand, let us say, 130 decibels, which is up to several pounds per square foot, so that this reference level in the decibel notation is an arbitrary one which is supposedly the lowest level which an average set of human ears can hear a 1000-cycle note. ▲

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Accelerated Firing Rates in Open

by E. T. W. Bailey,
Chief Combustion Engineer,
The Steel Co. of Canada, Ltd.
Hamilton, Ontario, Canada

AMONG the many interesting items which surround the operation of all open hearth furnaces is the rate of firing. It has long been known that the rate at which heat is developed in a furnace has a very direct bearing upon its output. Prior to 1939, factors of furnace fuel economy, refractory life, auxiliaries and general design proportions combined to limit the thermal input rates to rather modest values, compared with current figures. During the war, firing rates were moderately increased, as many of the above limitations became of secondary importance.

The literature dealing with open hearth practice twenty-five or thirty years ago reveals surprisingly few references to firing rates. What indications are given are usually in the form of Btu per ton or measurements in terms of oil pressures. The likely reason for this was, undoubtedly, the lack of rate-of-flow meters. The liquid meters commonly used were the integrating type. Many furnaces prior to this period, employed producer gas, with no attempt made to measure flow rates. It seems fair to conclude that it was during the late thirties that the installation of rate meters allowed some reference and attention to firing rates.

Even during the early forties, firing rates did not come in for much serious study. Mention is made of a 150-ton capacity furnace consuming oil at the rate of 300 U.S. gphr. Today many furnaces of this size have fuel firing rates double this value.

In 1946, experiments at Stelco[1]* using oxygen to accelerate or enrich open hearth flames disclosed, among other things, that much higher firing rates were not only possible, but very desirable. The results of these tests appear to have given operators and engineers an impetus to examine in more detail each and every factor which influenced firing rates. Some excellent work has been done throughout the industry. Among the most notable were tests showing the drastic slowing-down effects of air infiltration throughout the furnace system and the value of combustion air preheat, especially during the period of scrap melting.

The definition of accelerated firing, for the purpose of this paper, is taken to mean rates of thermal input substantially above those initially recommended by the furnace designers.

At the outset, it should be stressed, high firing rate is only one condition supporting high production. Success in this direction can only be assured if all conditions are in concert and properly proportioned.

This paper deals with the experiences at Stelco's No. 3 open hearth shop, where some gratifying results have been attained. Mention will also be made of more modest improvements at the No. 2 shop, where conditions combined to limit the usefulness of thermal input increases.

A description of Stelco's No. 3 shop appears in the 1954 Proceedings AISE, p 441. The shop has four 300-ton capacity furnaces and went into production in December, 1952. Eventually, it is expected the shop will be extended to include a total of eight or nine furnaces. This meant that many facilities were in oversupply to serve the four furnaces and this presented a wonderful opportunity to step out and see what could be achieved. It is important for this record that the principal favorable factors, which have combined and presented such opportunity be listed.

1. Favorable market for steel.
2. Ample reserve cold charge capacity.
3. Utility service main pipelines were oversized.
4. Control elements and individual furnace service pipelines were sized for future increases (i.e., initial firing rate 750 U.S. gphr of oil equipment designed for possible increase to 1100 U.S. gphr)
5. Reserve capacity for hot charging.
6. Ample pouring facilities.
7. Oversized forced and induced draft fans.
8. Excellent maintenance repair and rebuild tools, methods and plenty of room to use them effectively.
9. A determined group of supervisors backed by operators, engineering and service departments in maintaining efficiencies and promptly investigating and proving changes. Studies are continuously undertaken to spot weaknesses and devise means to overcome them.

It is conceded, that had possibly one of these major factors been deficient, results would have fallen short of those attained.

* Numbers in parentheses refer to Bibliography at end of article.

Hearth Furnaces

Perhaps the logical way to present an account of how firing rates were increased would be to describe the steps in chronological order over the past four years. It is well to keep in mind that changes are first tried on one furnace and, if successful, added to the others as the opportunity presents itself. This has the effect of producing over-all shop improvement results which appear deceptively gradual.

COLD CHARGING

The first four months of operation are discounted as a breaking in period.

Two fast and powerful charging machines were provided for four furnaces. It was not long before this capacity tempted operators to step up the tempo of scrap charging and melting. As this shop operates on 35 per cent hot metal (1956) it becomes doubly important to melt rapidly. Initial fuel rates were set at the maximums suggested by the designers and corresponded to 750 U.S. gphr fuel oil. It was not long before this was increased to 125,000,000 Btu per hr (825 U.S. gphr). Fortunately this was feasible without changes, because such a possibility had been foreseen.

CHECKERS

Three of the furnaces were built with double-pass checkers and one with single-pass checkers. It was soon evident that reduced firing rates from iron-in to lime-up had to be made in order to avoid damage to the hot pass. This gave the single pass furnace an apparent advantage. Some means to control excessive temperature entering the hot pass was sought. Drawing in atmospheric air was tried, but it was clumsy and taxed the drafting capacity. Water was sprayed into the slag pockets, using compressed air for atomization and proved very effective. Waste gases have their temperature reduced from 2700 F to 2500 F, which leaves the apparent temperature of the brickwork at the top of the hot pass about 2430 F. Up to 20 gpm of water are introduced and controlled automatically from the temperature radiated from the brickwork at the entrance to the hot pass. This scheme overcame the chief disadvantage of the double-pass checkers and firing rates were restored to maximum desired values for all furnaces throughout the heat.

FIRST PLATEAU

During the first period of fuel rate increase, maximum fuel rate was 125,000,000 Btu per hr (825 U.S. gphr oil)—hot metal 49.2 per cent—heat size 298 tons—heat time 11.3 hr—tap-to-tap tons per hour 26.4—Btu per ton, 3,854,000.

SECOND PLATEAU

Having obtained control of excessive checker temperature, firing conditions were increased for the period of the second plateau. Maximum fuel rate was 145,000,000 Btu per hr (950 U.S. gphr) oil—hot metal 45.9 per cent—heat size 300 tons—heat time 10.7 hr—tap-to-tap per hr 28.0—Btu per ton 3,951,000.

FORCED DRAFT FANS

In order to prepare for further increase in thermal input, alterations had to be made to the ranges of the fuel, steam and combustion air measuring elements; waste heat boiler baffles and, most important, to the forced draft fan capacity. The original fans were rated at 30,000 cfm; 5-in. water static pressure, and 70 F temperature requiring 35 hp. It was decided to replace them with fans rated at 55,000 cfm; 9.6 in. water static pressure and 120 F temperature requiring 109 hp. The higher temperature rating of this fan should be noted as being more in line with actual operating conditions.

THIRD PLATEAU

The above changes enabled conditions for the third plateau to become: maximum fuel rate 190,000,000 Btu per hr (1250 U.S. gphr oil)—hot metal 35.1 per cent—heat size 316 tons—tap-to-tap time 9.3 hr—tons per hr 34.0—Btu per ton 3,629,000. This move resulted in the most significant increase, but was only possible after the earlier hurdles had been successfully taken.

BURNERS

The burners used are an artillery type with home-made mixing devices. Essentially they resemble most others used in the industry. Fortunately, the waste heat boilers were designed to supply steam at 275 psig and 515 F total temperature. Most of this pressure is now being used to maintain 1250 U.S. gphr fuel rates. Six to seven pounds of steam are required to mix with one gallon of oil. The burners are constructed to use coke oven gas under 20-psig pressure, along with oil during the meltdown periods. The proportions of gas and oil are automatically adjusted to maintain plant coke oven gas pressures within a predetermined range. The coke oven gas seems to produce faster melting, and with a high percentage of scrap in the charge, is another condition which contributes something to the over-all performance.

During the campaigns to increase fuel input rates, trouble was experienced with steam hose failures. These hoses were made of alloy steel and were 1½ in. size. Tests were conducted by the staff to determine the degree and frequency of vibrations in the hose. The findings were startling and were later confirmed by the manufacturer. All steam hoses were increased to 2 in. diam and failures have, to date, been eliminated.

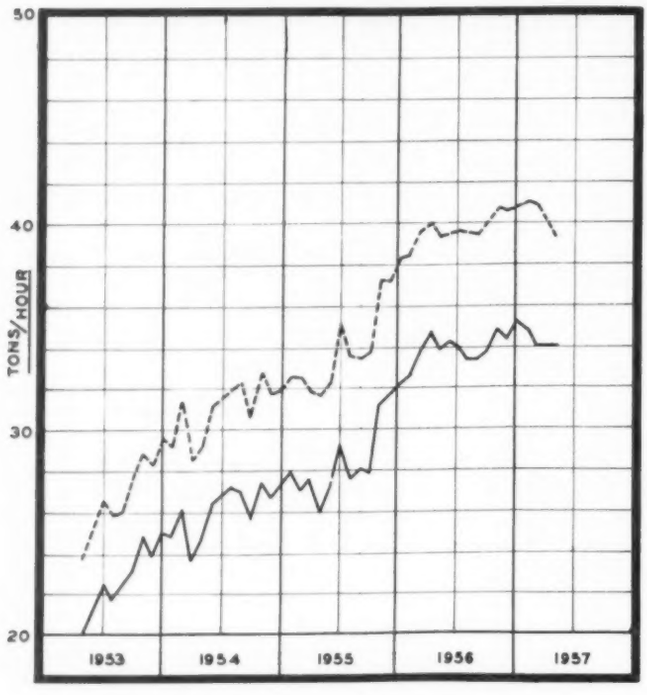

Figure 1 — This chart shows the rate of steel production per hour on a charge-to-tap and tap-to-tap basis.

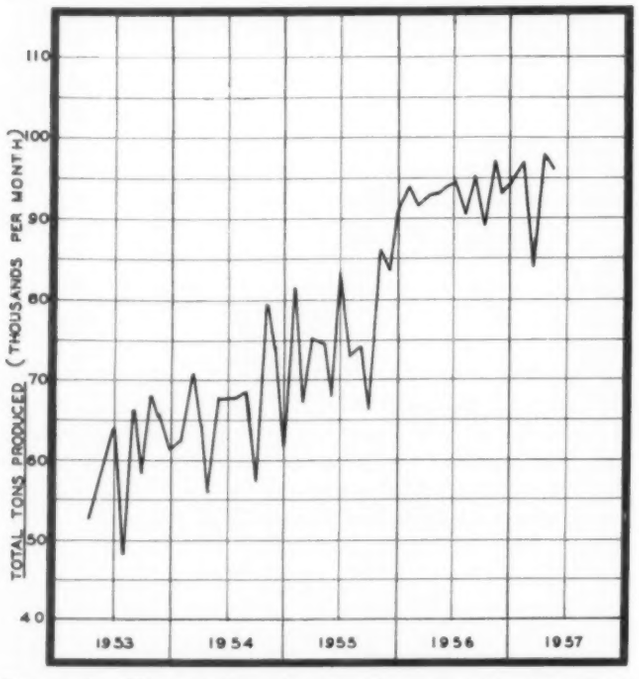

Figure 2 — The total production from month to month over the four-year period shows steadily increasing trend.

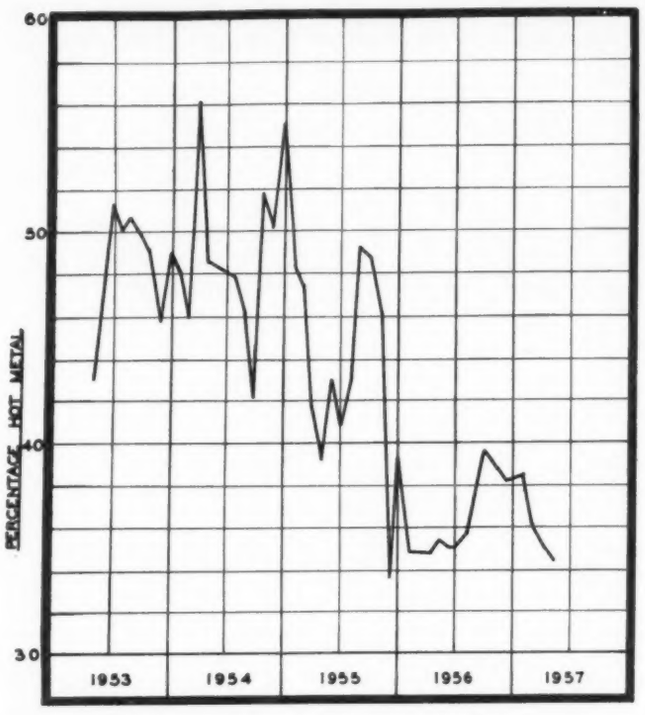

Figure 3 — The per cent hot metal used has been substantially decreased.

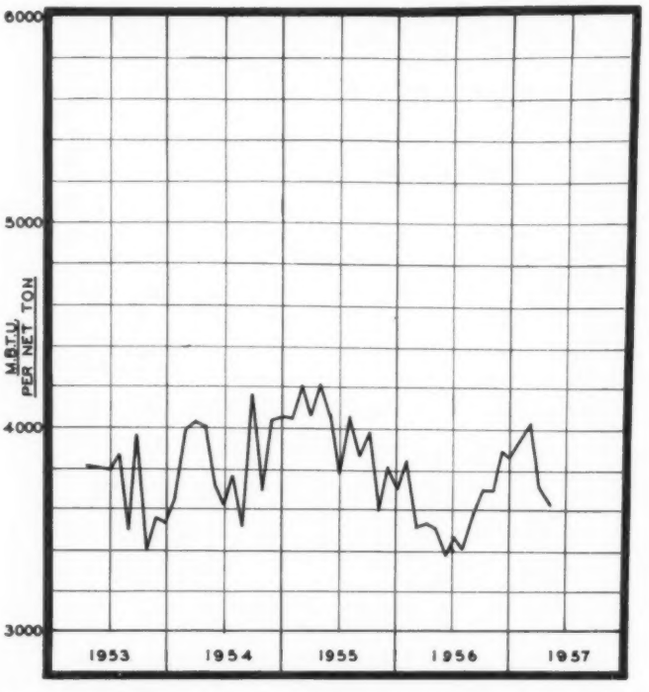

Figure 4 — The fuel used per ton of steel has been held within reasonable limits, considering the increased firing rates.

INSTRUMENTS AND CONTROLLERS

While a few changes have been made, chiefly in the ranges of measuring components, the basic scheme has remained intact and has proven to be an important factor in achieving the results indicated. The operators do a lot of their "flying" by instruments.

In order to get a clearer picture of the results over the four-year period from April, 1953 to April, 1957, the following graphs have been prepared.

Figure 1 shows the tons per hour plotted at monthly intervals for both charge-to-tap and tap-to-tap conditions. The charge-to-tap values more accurately reflect the results of fuel firing rates as the fettling periods are discounted. Both curves show a generally rising slope over virtually the whole four years.

After all, the total tons produced (Figure 2) is the result that really matters. While these tonnages, plotted at monthly intervals, increase in almost direct proportion to increases in firing rates, they, neverthe-

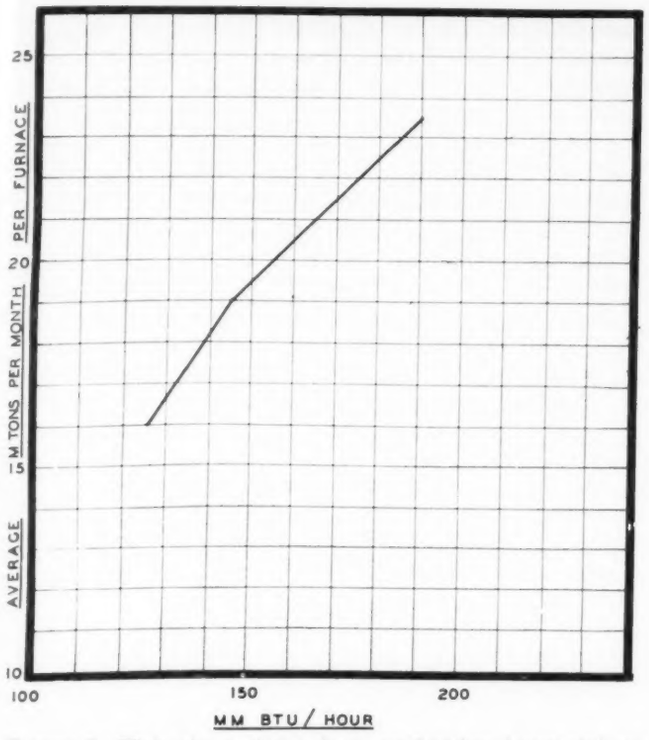

Figure 5—This chart shows how production increased as fuel input rates increased.

less, are influenced by many other factors—to mention one: better maintenance and rebuild methods. It is interesting to note that the total tonnage produced by the shop in April, 1957, was 80 per cent higher than that produced in April, 1953.

Figure 3 shows the decline in the percentage of hot metal in the charges. With a relatively fixed amount of hot metal available, it becomes necessary to use a greater proportion of scrap in order to increase the production of steel.

Figure 4 attests that the fuel consumption per ton has been held within a satisfactory range considering the drastic changes in firing rates that took place in the four-year period. It might be noted that the reduction, achieved late in 1955 and for the first half of 1956, accompanied the changes in forced draft fan capacity.

Figure 5 is interesting in that it relates firing rate in million Btu per hr to tons of steel produced per month. The slope is plotted for the three plateaus outlined and confirms that the firing rate change was the chief factor influencing the shop production.

NO. 2 SHOP

Comparisons of total heat input for charge weight, together with relative surface areas, indicated that the 300-ton furnaces in No. 3 shop in 1953 lagged behind Stelco's 180-ton furnaces in the No. 2 shop. Instead of 27 tons per hr, they should have produced 30 tons per hr. Since that time, they have gone on to produce at the rate of 34 tons per hr. The same increase could not easily be had in No. 2 shop, because of crowded conditions for all services.

Two improvements were made. Controlling equipment was modernized and the furnaces supplied with 275-psig steam, instead of 150-psig used formerly. These two items are principally responsible for the increased output of 30 per cent, comparing the period April–December, 1955 with January–December 1956.

FOURTH PLATEAU

The next objective is set at a heat input rate of 220,000,000 Btu per hr (1,450-U.S.gphr oil). To attempt to reach this thermal input more expensive changes have to be made. The most important is the replacement of induced draft fans. This is now underway. The orginal fans had a capacity of 94,000 cfm at 14.6 in. water static pressure, when handling gas at 600 F and driven by 300-hp motors. The new fans will have a capacity of 160,000 cfm; 15-in. water static pressure, while handling gas at 600 F and will be driven by 500-hp motors.

Studies are being made on atmosphere control under the inside surface of the roof and the use of 400-psig steam pressure to attain higher jet momentum at the burner tip.

There are plenty of indications that these proposed firing rates may reduce brick life below a desired minimum. Certainly ultimate firing rates can be foreseen, which will present a challenge to the best refractories now made. An urgent call is already going out for better refractory materials.

The 300-ton open hearth furnaces have a potential combustion space from bridge wall to bridge wall of 10,820 cu ft. A heat input rate corresponding to 190,000,000 Btu per hr releases only 17,600 Btu per cu ft. The literature indicates that some burners have heat release rates as much as 40,000,000 Btu per hr per cu ft of combustion volume. There is little likelihood of approaching any such values in open hearth furnaces, chiefly because they would be unsuited to the bulky volume to be heated and because temperature differentials between flame and work are relatively small for most of the heat time. Nevertheless, there appears to be plenty of room for further increases in firing rates, especially if we can be provided with suitable refractory materials or better means to control overheating the vital parts of the furnace structure.

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Discussion

PRESENTED BY

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E. T. W. BAILEY, Chief Combustion Engineer, The Steel Company of Canada, Ltd., Hamilton, Ontario, Canada

Member: On refractory life and roof life you did mention that you are looking for something better. Do

you have any figures to substantiate whether it is good or bad or is it desirable to go to those high firing rates?

Thomas Hess: I think the first thing that needs to be said is that this certainly represents a wonderful job of open hearth management. The graph which is most significant is the one on which Mr. Bailey has plotted monthly production rather than tons per hour. While he makes a plea for a better refractory, he sure has done a good job of living with the refractories available.

I think one very good example of their good management is making sure they have enough air to burn the oil. I recall hearing the importance of this at the first open hearth meeting I ever attended. There's nothing harder on an open hearth roof than a reducing atmosphere. They must certainly have avoided that to keep that tons-per-shop going up along with the tons-per-hour.

I am a little dubious of No. 2 shop getting 30 per cent more tonnage with just higher steam pressure and controls on the furnaces. I know my superior is going to ask me about that.

George Krapf: I think that the engineering job and the operating job done in this shop is outstanding. I would like to suggest, however, that you might have the answer to some of your questions in regard to "Why can't we do it in our shop?" in the first part of Mr. Bailey's paper in which he discussed the materials handling equipment that serves these furnaces. A shop cannot do this unless you have the handling equipment to do it with.

We all know how frustrated we have been in working on one furnace in a shop and getting that furnace to increase its production say 10 to 20 per cent, and then find that we could not permanently keep the pace because we favored that furnace and the rest of the furnaces in the shop suffered. So it is not possible to attain these production rates if the material cannot be handled. However, if the facilities to handle materials are available, then we are remiss in our jobs in not attaining everything that Mr. Bailey has attained in his shop.

He has taken advantage of all the knowledge that he has gained and which has been so freely distributed in the industry. It is there for all of us to study. I think, of all the production and experimental papers that I have listened to, this one emphasizes what can be done if full advantage is taken of every factor that is available. He certainly has been backed by a far-sighted management who has obtained for him the facilities necessary to do this production job. I think it was a job very well done, and again I would like to congratulate him.

John S. Morris: Mr. Bailey, you certainly have made a remarkable record on the furnaces. Originally the furnace was probably designed for flue gas velocities and downtake velocities to take care of 800 gphr of oil. Since that time you have increased quite a bit the flow of oil. You have twice changed your fans to larger size, thereby greatly increasing the velocity of the flue gases on the outlet end and through the checkers. What effect have these changes had on the life of the downtake and also your checkers?

F. C. McGough: Mr. Bailey, it is apparent that you intend to continue your high firing rate program and might even consider increased maximum inputs. In the event additional furnaces would be constructed in this shop, would they be equipped with single or double-pass regenerators in view of your experiences with both types?

E. T. W. Bailey: I think the fact that we have increased firing rates and plan to increase them further, answers the member's question as to whether high firing rates are good or bad. Our production has gone up 80 per cent over the four years reviewed and we feel there is still potential in the furnaces before we reach the economical boundary.

I can assure Mr. Hess that the No. 2 shop production increase was basically accurate. In considering these things, one has to know what degree of the shops' potential was being realized before the improvements were made.

In answer to Mr. Morris' question, I can say the downtakes gave considerable trouble. They were cleared of partitions and opened up as far as possible after steelwork was altered.

Mr. McGough's question as to whether we would choose single or double-pass regenerators in event additional furnaces were constructed, is a leading one. I am afraid there would be considerable debate before a choice was made. The single pass is not quite as efficient, as evidenced by the larger amount of steam produced in the waste heat boiler. Nevertheless, as long as the steam can be used, the over-all efficiency is the same and the single-pass does offer some operating advantages. ▲

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Recent Advances in Control Systems for Continuous Processing Lines

. . . . news tools such as static components and new techniques have made control systems for continuous processing lines easier to install, tune up and maintain . . . . increased accuracy and flexibility have been obtained and overall system performance has been improved . . . .

by C. P. Brooks,
Application Engineer,
and J. T. Bradford,
Systems Engineer,
Industry Control Dept.,
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Roanoke, Va.

THERE are many factors that have contributed to the excellent over-all performance of modern steel mill continuous processing lines. Operating experience and technical advances of the steel producers, machinery and furnace builders, and electrical manufacturers are prime examples. The co-ordinated teamwork that has existed between these groups cannot be overstressed. However, another prime factor has been a number of recent advances in the control systems, which have been made possible by the availability of new tools for the control system. These new tools include static components, such as magnetic amplifiers, d-c current transformers, transistors and high-current silicon rectifiers.

The intent of this paper is to explain how these new tools have been used in some of the recent advances in control systems to improve over-all line performance. The advances, to improve or provide such functions as: (1) preset line speed control, (2) modulated loop positioning, (3) voltage rate control of acceleration and deceleration, (4) current totalizing and regulation of electrolytic processes, and (5) static d-c power supplies, will be described.

CONTINUOUS PROCESSING LINES DESCRIPTION

Continuous processing lines are good examples of where the steel industry has obtained a start towards automation. Continuous lines have combined several process functions formerly accomplished by batch methods and noncontinuous lines, into co-ordinated continuous processes. In a continuous line, the major process functions are performed while the steel is in strip form rather than in coils or sheets. Continuous lines provide increased output of a better product more efficiently with reduced operator effort.

Three of the largest continuous processing lines are galvanizing, tinplate annealing and electrolytic tinning. Although the major purpose of each line is naturally different, each line is similar in layout. That is, each is divided into three sections—entry, center and delivery. The basic functions of the strip propelling drives of each line are similar for each corresponding section. Therefore, the control systems for each will be similar.

Figure 1 shows a simplified line layout of a continuous electrolytic tinning line. The major process function, tinning, is performed in the center section. This section runs continuously. The entry section is separated from the center by storage loops as indicated, or by a storage tower. This provides a continuous flow of strip to the center section while the entry is stopped for shearing and welding the ends of coils together. The strip may be coiled as indicated, or sheared, inspected and sorted in the delivery section. Although the example shown has no storage between center and delivery sections, the line does not have to be stopped for coil changes. With the line at reduced speed, the selective shear will cut the strip and deflect the leading edge to the empty reel.

A description of the basic process functions of each section of one variety of galvanizing line, or a tin-

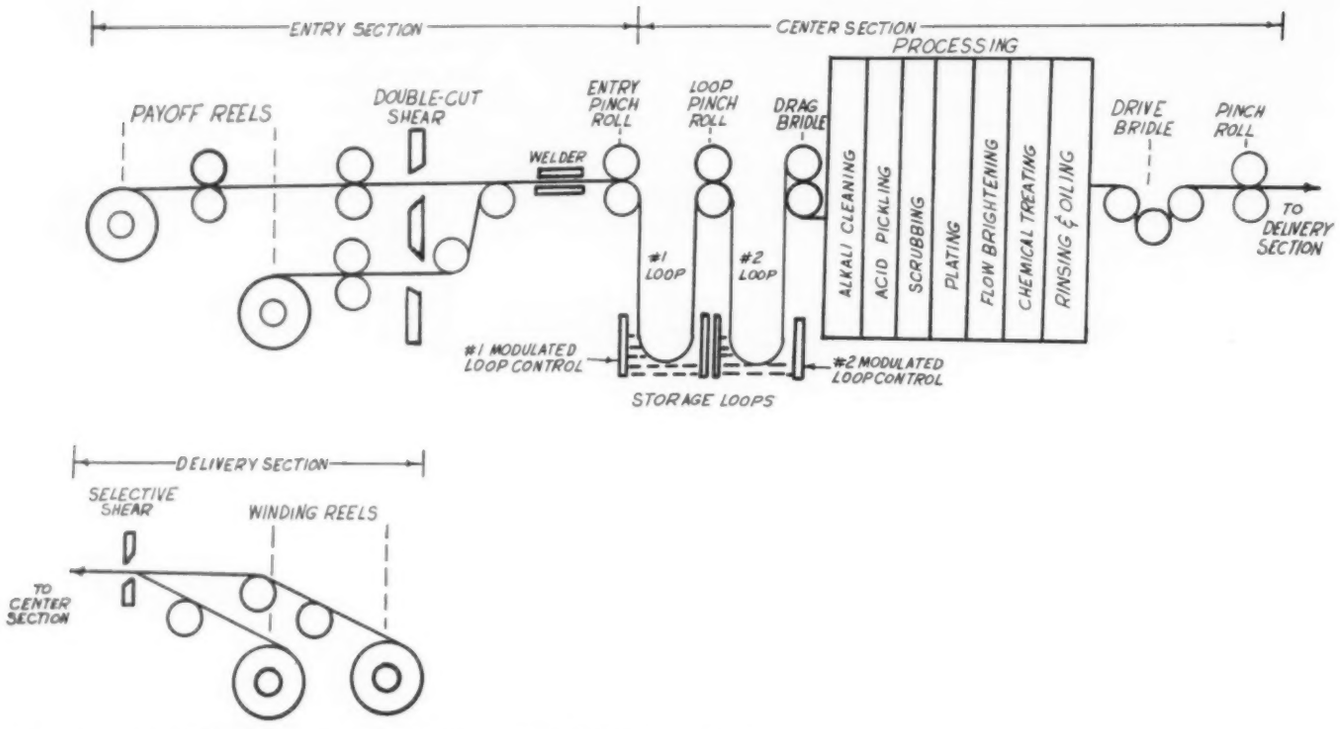


Figure 1 — Simplified layout of a continuous electrolytic tinning line.

plate annealing line, would be similar to tinning. However, the chief process functions of the center section of the galvanizing line are annealing and zinc coating, whereas, the major process function of the center section of the annealing line is annealing. The center and delivery sections of a galvanizing or tinplate annealing line would be separated by storage loops, or tower, so the delivery section as well as the entry may be independently stopped.

CONTINUOUS PROCESSING LINE CONTROL SYSTEMS FUNCTIONS

In order to show how some of the recent advances in control systems have been applied to continuous processing lines, the main control functions that are often provided for over-all control of the line are described. Special attention is given to some functions that have been improved by recent advances, described later in more detail. Figure 2 shows a simplified adjustable voltage control diagram and plating control diagram for an electrolytic tinning line.

Center Section

1. Strip speed regulated to desired value—by adjusting generator voltage using master motor-operated rheostat as reference for desired speed, and drive bridle speed as feedback.

2. Practically stepless adjustment of strip speed over wide range—by adjustable voltage control. Each button of the master motor operated rheostat provides a strip speed change of no more than 10 fpm. It will provide smooth, relatively slow, adjustable acceleration and deceleration rates.

3. Line preset speed control—by positioning the master motor operated rheostat to thread, medium, or high line speed as preset by the operator, with repetitive accuracy of better than one per cent.

Improved line preset speed control will be the first recent advance to be described. The availability of the transistor for the design of a dependable, high gain amplifier made this new and proven circuit possible. This is a static position regulator that will regulate accurately the line motor operated rheostat to the position called for by the operator. One previous preset speed scheme utilized double-coil voltage sensitive relays to position the line MRH. The relay method required excessive tune-up time and high maintenance. The new preset speed control reduces tune-up and maintenance time, and provides increased reliability and accuracy.

4. Smooth, fast, co-ordinated stops under emergency conditions—by regenerative braking with current limit control.

5. Accurate strip tension control—by current regulation of drag bridle. Due to wide tension ranges required on a galvanizing or tinplate annealing line, tension regulation on these lines will normally be controlled by regulating the position of a preloaded dancer roll at entry of furnace.

6. In addition to the control for the drives, control of the various electrolytic processes is required. For example, tinning line plating current totalizing and regulation, with an accuracy of about one per cent.

This function has been recently advanced to a completely static system by the use of individual d-c current transformers for each generator or rectifier, totalizing units for top, bottom and grand total, and static transistor-magnetic amplifier current regulators. The use of individual d-c current transformers instead of shunts provides circuit isolation and decreased installation expense. Some previous totalizing schemes have employed resistor networks and a galvanometer-electronic amplifier. Static totalizing d-c current transformers have no moving parts; thus installation and maintenance costs will be reduced. The use of a tran-

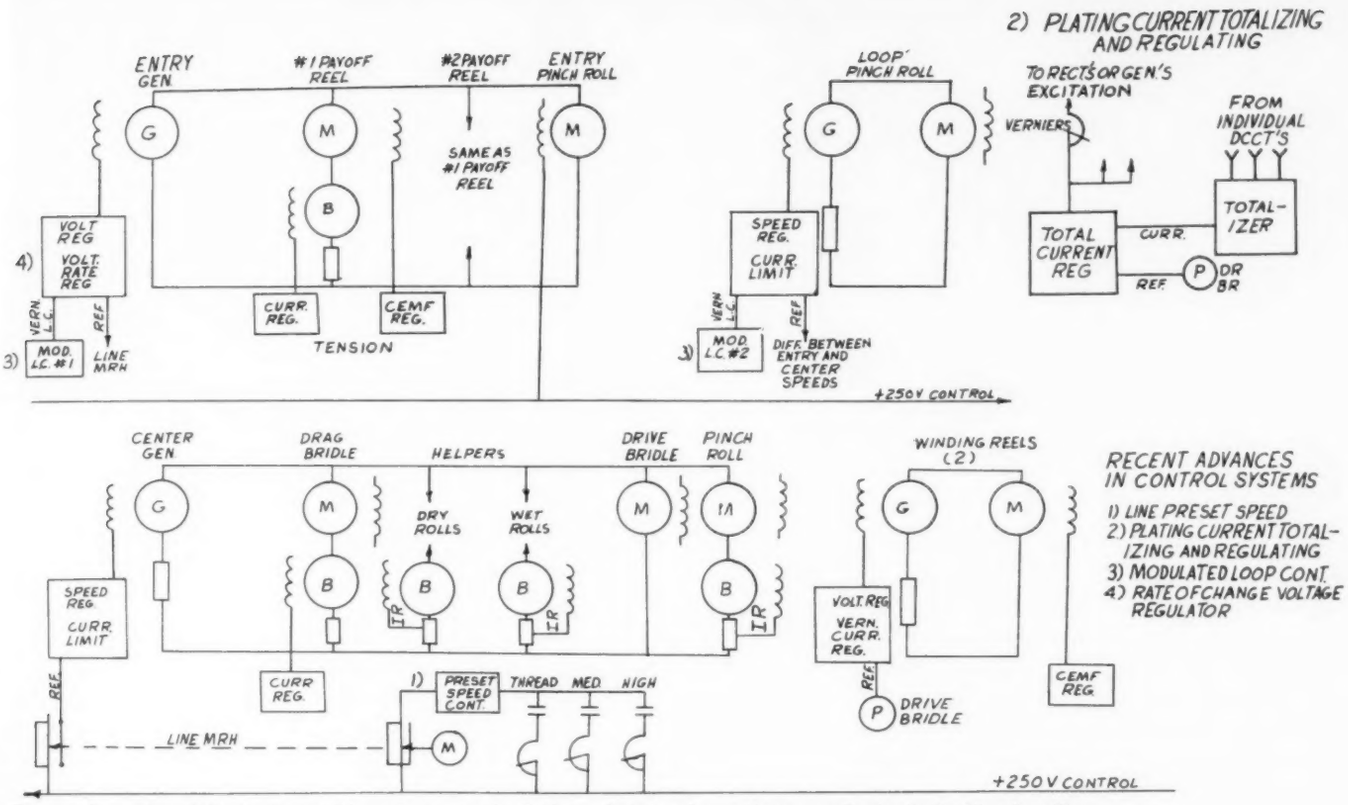


Figure 2 — Simplified adjustable voltage and plating circuit of continuous electrolytic tinning line.

sistor-magnetic amplifier regulator to regulate total current makes the system completely static and highly accurate.

Entry Section

1. Accurate speed match to center section during normal operation—by voltage regulation with a dial of MRH as reference and with vernier modulated loop control of No. 1 storage loop.

Another recent advance is static modulated loop control. Modulated loop controls provide a stepless output as a function of loop position. Modulated loop controls provide improved performance and flexibility over other types, such as mechanical or photoelectric limit switches, since the latter do not provide a stepless output. The present static modulated loop control was developed in several steps. Thyratrons were replaced by an electronic rotating regulater, which was then replaced by the electronic magnetic amplifier system. This system has now been advanced by the transistor to supersede the electronic amplifier. The transistor-magnetic amplifier provides long life and reliability that was not associated with electronic components of previous systems.

2. Accurate strip tension control of pay off reels—by magnetic amplifier current regulator acting on booster and magnetic amplifier CEMF regulator for motor. Inertia compensation during acceleration and deceleration is included.

3. Fast, stepless, independent stopping and starting for coil changes—by rate of voltage control of acceleration and deceleration, with signal from modulated loop control No. 1 to provide overspeed on restarting to fill No. 1 loop.

The function of fast, stepless independent starting and stopping for coil changes is one of the most important functions required of the control system. This function has been advanced by the rate of change voltage regulator, consisting of a pair of magnetic amplifier in push-pull and a rotating regulator. This system provides improved performance over alternate methods of starting and stopping. Motor operated rheostats provide smooth starts and stops, but the maximum rate is limited and maintenance is a problem. Acceleration and deceleration by changing generator voltage in timed steps is less flexible and not smooth. Current limit control is fast, but less flexible in setup adjustment, and not so smooth and linear.

4. If multiple storage loops are used, equal emptying and filling rates of each loop are provided. For a double loop system as shown, the looping pit pinch roll is speed regulated to the overage of the entry and center section speeds. For normal line operation, the modulated loop control No. 2 acts as a vernier on the speed regulator. During restarting, the modulated loop control No. 2 provides overspeed.

Delivery Section

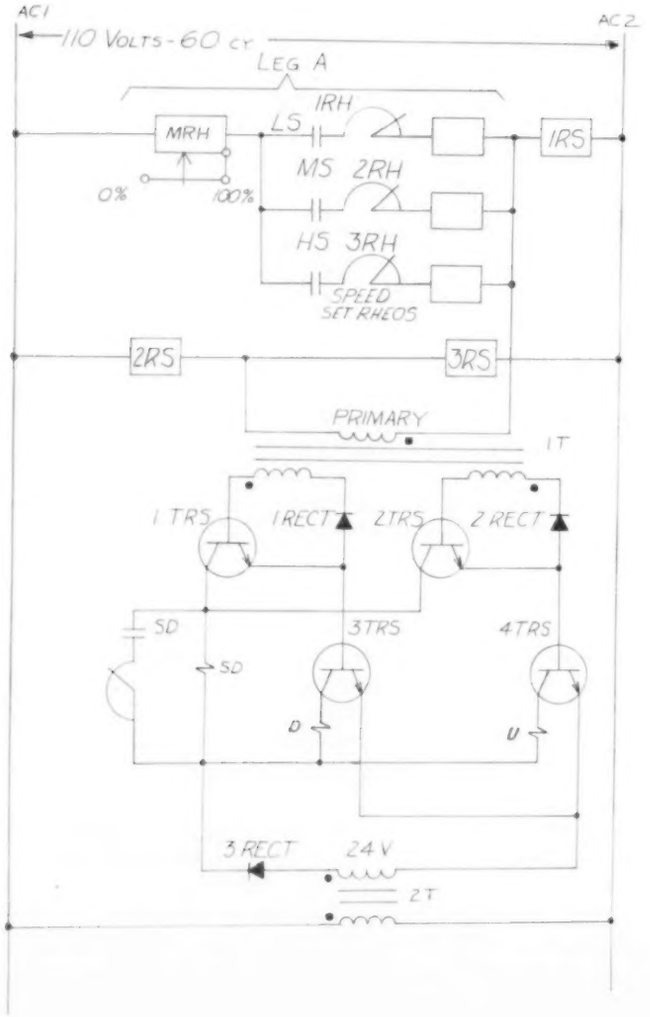
For the tinning line example where no delivery storage unit is provided, the reel voltage regulator with center section drive bridle speed as reference brings the delivery generator voltage in range with respect to line speed. Tension is regulated by a magnetic amplifier current regulator acting as a vernier on the voltage regulator, and by a magnetic amplifier motor CEMF regulator. Inertia compensation during acceleration and deceleration is included as well as lead speed adjustment for threading on the fly.

For a line with delivery section storage, the delivery section would include a drag bridle for the reel to pull against. Control system functions would be essentially as described for entry, if a double loop system is used.

Some of the functions just described have been improved by recent advances. These recent advances in control system functions are described in more detail as follows:

Line preset speed control—Figure 3 shows the circuit for the preset speed control. The circuit is a position regulator that positions the line motor-operated rheostat (MRH) to a desired setting. The reference for the position regulator, representing the desired speed, is preset by the operator on hand operated rheostats at the line. The circuit is based on the principle of the Wheatstone bridge. The MRH and the operator's presetting rheostats make up one leg of the bridge, while the resistors 1RS, 2RS, and 3RS make up the other three legs of the bridge. The primary of transformer 1T has a voltage across it if there is any unbalance in the bridge. The secondaries of 1T, transistors 1TRS, 2TRS, and rectifier 3RECT act as a half wave descriminator. 1TRS and 2TRS can only pass current from their collector to emitter on the half cycles when AC1 is plus with respect to AC2. If leg A of the bridge is higher in ohms than the other three legs (when AC1 is plus with respect to AC2), the right hand secondary of 1T is of such polarity to pass current through rectifier 2RECT, and from the base to

Figure 3 — Line preset speed circuit is a position regulator that sets the line motor-operated rheostat.



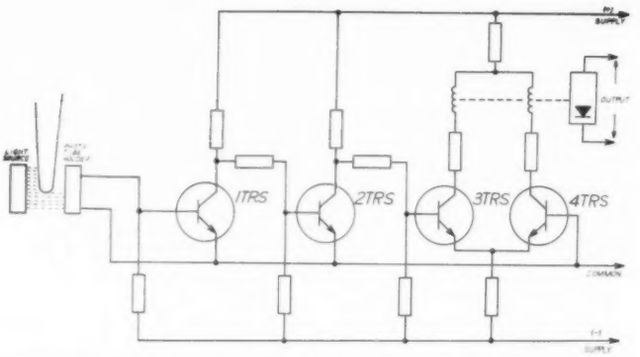
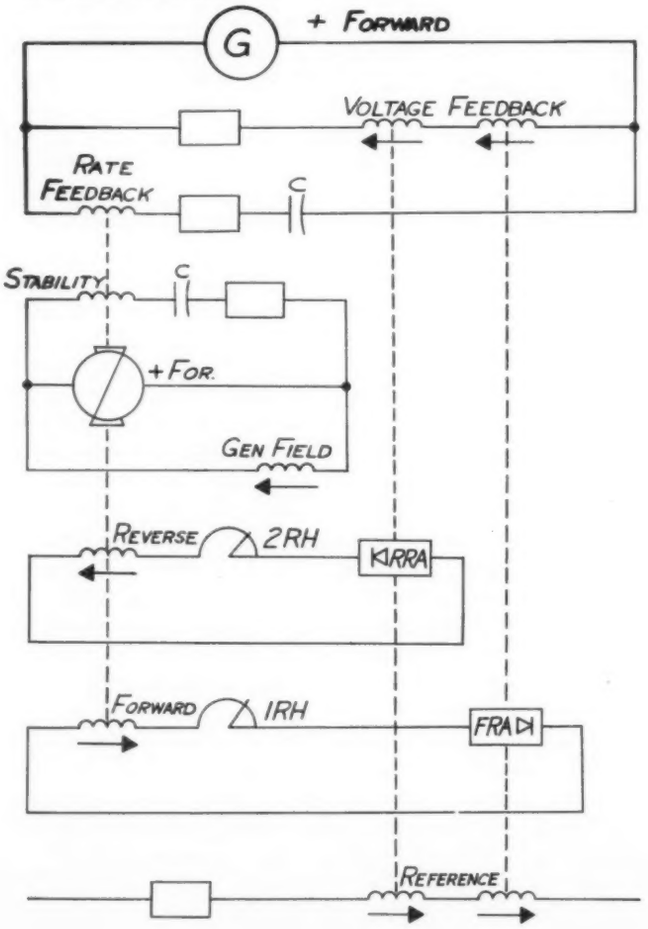


Figure 4 — Simplified electrical diagram of modulated loop control which provides stepless output.

the emitter of transistor 2TRS. This turns transistor 2TRS on during the half cycles AC1 is plus with respect to AC2. If leg A had been unbalanced in the other direction (less ohms than the other legs), transistor 1TRS would have turned on during the conducting half cycles.

Whether 1TRS or 2TRS is conducting, therefore, depends on which way leg A is unbalanced. The magnitude of conduction depends on how far the bridge is unbalanced. Transistors 3TRS and 4TRS are used as amplifiers to amplify the output of 1TRS or 2TRS to the level required to pick up a relay. This runs the MRH in the direction to balance the bridge. For example, if the operator wants to raise the run speed, rheostat 3RH is turned clockwise unbalancing the

Figure 5 — Rate of change voltage regulator circuit uses two magnetic amplifiers.



bridge in the direction to pick up the "up" relay. The MRH is positioned to the desired setting, rebalancing the bridge.

On large changes, the load current of 1TRS or 2TRS is of sufficient magnitude to pick up relay SD also. This allows the MRH to run at a high speed. As the bridge is balanced by positioning the MRH, the current through SD decreases. Near the final balance, SD drops out slowing down the MRH, preventing overshoot.

The position regulator is of sufficient gain to give a repetitive accuracy of less than 1 per cent. That is, in coming up or down to a given point, the rheostat will stop within 1 per cent (of the total travel) of that same point. The unique design of the bridge, constant ohms per leg when the bridge is balanced, gives the system the same sensitivity regardless of where the MRH is being positioned.

Static modulated loop control—Figure 4 shows a simplified electrical diagram of the modulated loop control. Modulated loop controls provide stepless output as a function of loop position. Static equipments consisting of phototubes, transistors, and magnetic amplifiers are now in operation. Scanning equipment mounted at the line consisting of a light source and a row of phototubes gives a feedback of actual loop position. The output of the phototubes varies as a function of the amount of light that reaches them. This output is then amplified in a three-stage transistor amplifier. The transistors are potted in resin blocks to give industrial clearances not usually available on transistors. The output of the transistor amplifier is next fed to a 15-volt-amp magnetic amplifier which acts as the driver for the rest of the system.

The modulated loop control is actually a position regulator. For example, if the loop is not full enough, the amount of light reaching the phototubes increases. This causes the output of the phototube holder to increase transistor 1TRS collector current. The collector current of 2TRS, which drives the long tailed pair consisting of 3TRS and 4TRS, is decreased. The long tail pair which drives the magnetic amplifier in push-pull, is driven in the direction to fill the loop. The loop position is regulated to the center of the phototube holder, at which time the long tailed pair is balanced. As a result of computer studies, new stabilizing circuits that give improved performance are included in the circuitry.

Rate of change voltage regulator—Figure 5 shows the circuit for the rate regulator. Two magnetic amplifiers are used in push-pull to excite a rotating regulator, which in turn excites the generator. During normal operation the circuit acts as a high gain voltage regulator. However, if the reference is changed abruptly as in starting, stopping, or changing speed, the magnetic amplifiers will saturate. For example, if the voltage is zero and a reference is applied, the forward magnetic amplifier will saturate in the ON direction, and the reverse unit will saturate in the OFF direction. This supplies a constant reference to the rotating regulator and opens the voltage regulator loop. The constant reference causes the rotating regulator to excite the generator. As the generator voltage rises, the rate feedback circuit provides a feedback that is proportional to the rate of rise of generator voltage. The difference between the constant reference supplied by

Figure 6 — D-c current transformer is compact.

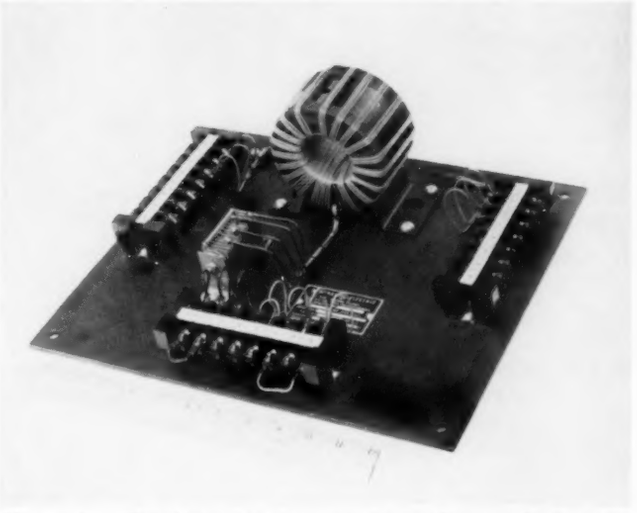


Figure 7 — Totalizing d-c current transformer has many inputs.

the saturated magnetic amplifiers and the rate feedback is the error, or net excitation, to the rate regulator. As long as the magnetic amplifiers are saturated a constant rate of rise of generator voltage will be regulated. When the generator voltage nears the desired value the magnetic amplifiers come out of saturation and the normal voltage regulator takes over, regulating the desired value.

If the generator had been up to voltage and the reference to the voltage regulator removed, the magnetic amplifiers would have saturated in the opposite directions. The rate of decay of generator voltage would have been regulated to a constant value.

The rate of rise or decay of voltage (accelerating and decelerating times) are independently and easily adjustable. By increasing the constant reference to the rate regulator, the rate of change of voltage will be regulated to a higher constant value. Decreasing 1RH will cause the voltage to rise faster or the line to start faster. Decreasing 2RH will cause the voltage to decay faster or the line to stop quicker.

Since the voltage rises or decays at a constant rate, the motors will change speed at a constant rate; and the armature current needed to accelerate or decelerate the motors will remain constant. The higher the rate of change or voltage, the higher the armature current needed for acceleration or deceleration. The rate of change of voltage is therefore usually set to keep the

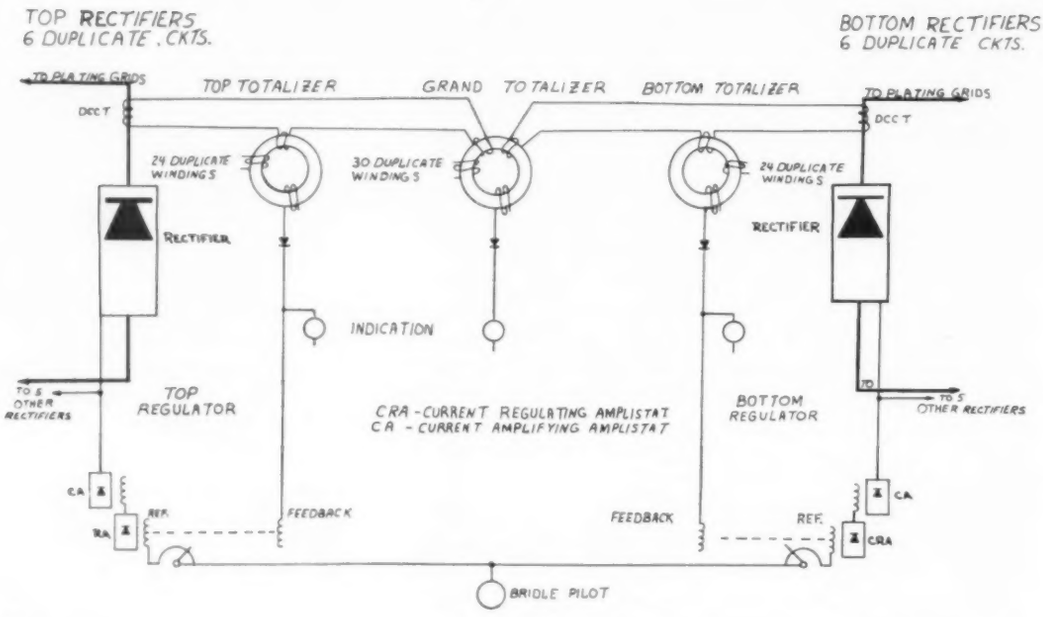


Figure 8 — Simplified electrical circuit of tinning line plating totalizing and regulating provides a reliable high gain system.

machines within their designed limits.

The circuit constants determine how long the change of voltage is linear, or the regulator is on rate during a change. A high gain in the rate regulator will allow the system to get on rate sooner, and a high gain in the voltage regulator will keep the system on rate longer. A properly designed system will stay on rate 90 per cent of the time.

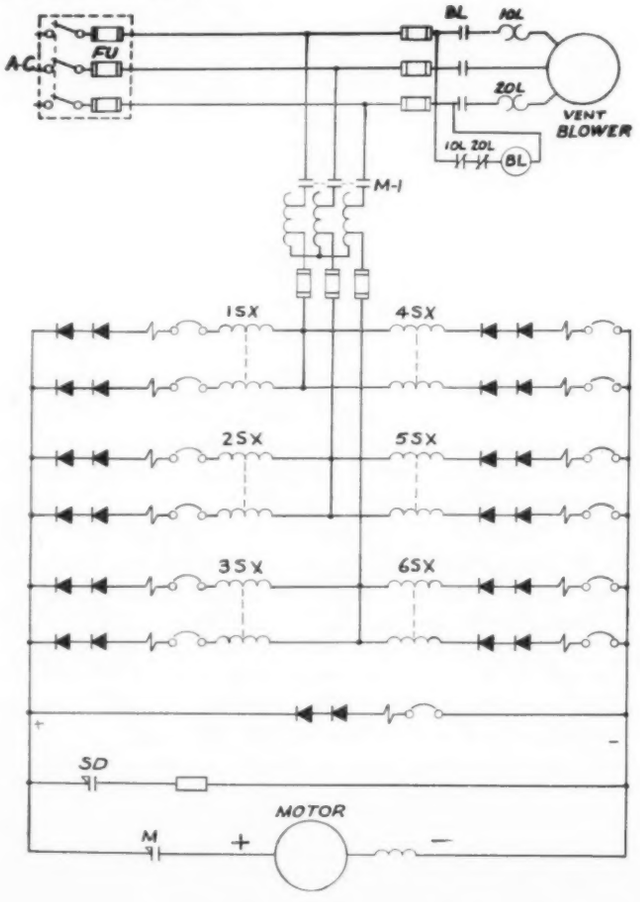
Tinning line plating current totalizing and regulation —D-c current transformers have been used for a number of years to obtain indication of high d-c currents, such as used in electrolytic cleaning, pickling, and plating. Figure 6 shows two d-c current transformers, and Figure 7 shows a totalizing d-c current transformer.

The totalizer has many inputs which can be fed from the individual d-c current transformers in each low voltage generator or rectifier circuit. The output from the totalizer is the total current in the process. For example, in tin plating, d-c current transformer totalizers have been used for top, bottom, and total plating amperes. The output of the totalizer can then be used for both indication and feedback to the low voltage or process regulators.

Figure 8 is a one line diagram of a recently installed tin plating system. The d-c current transformer totalizing system in conjunction with the magnetic amplifier provide a reliable high gain system. Plating accuracies in the order of one per cent are obtained. The addition of extra windings on the totalizers make the system flexible. For example, when rectifiers are transferred from the top to bottom for differential plating, the feedback is easily shifted from the top to bottom totalizer. In another case, if the top regulator is out of service, all the rectifiers can be transferred to the bottom regulator, and the grand totalizer used as the feedback.

Static supplies for motors—The availabiiity of the high voltage, high current silicon rectifier has made practical the design of larger static power supplies for running motors direct. Static supplies have been built for processing lines in sizes up to 100 kw. Larger sizes are contemplated. Figure 9 shows the circuit of a typical drive. A magnetic amplifier of the three-phase full wave bridge type is used to control the output voltage. The magnetic amplifier receives its a-c power through a conventional starter. An autotransformer converts the incoming voltage to the level required by the magnetic amplifier design. Current limit fuses are available to protect the rectifiers on bus faults. The rectifiers are connected in series to obtain the necessary PIV rating, and in parallel to obtain the current rating. Each series group is in series with a small breaker to protect the remainder of the rectifier if that group fails on inverse voltage. Each series group and its

Figure 9 — Typical electrical circuit of static d-c power supply for motors.



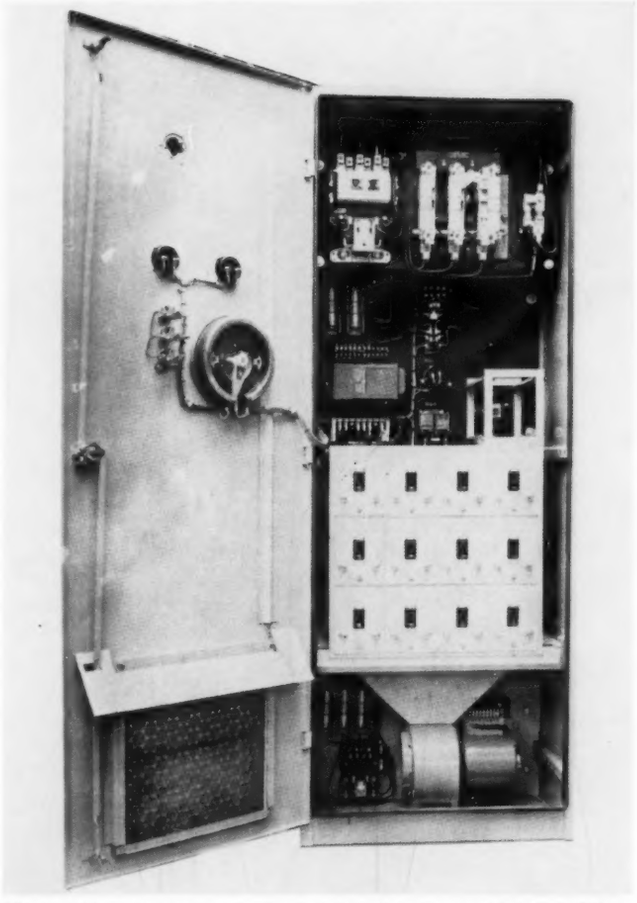


Figure 10 — Static d-c power supply is rated 50 hp, 330 v, (front view).

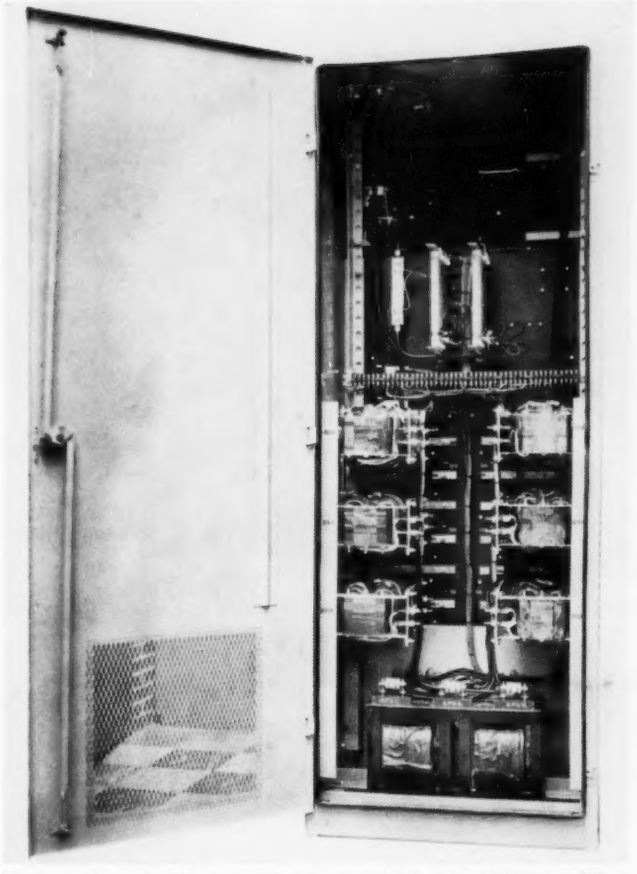


Figure 11 — Static d-c power supply is rated 50 hp, 330 v, (rear view).

breaker are mounted in a removable drawer. See Figure 10. In event of a cell failure a drawer can be quickly replaced by a spare. The faulty cells can then be replaced while the line resumes production.

On the bottom of Figure 10 is a blower. Air is blown up through the drawers and over the enclosed rectifiers and their cooling fins. This allows the supply to have a 200-per cent rating for one minute. In Figure 11 the magnetic amplifier reactors are mounted on the sides and the autotransformer is on the bottom. The ventilating air is blown over these components after it comes through the rectifier drawers and before it leaves the case.

On the equipments supplied to date, static voltage regulators with rate of change of voltage control have been supplied. The regulators of the magnetic amplifier type make the entire system static. Figure 12 shows a recording of the power supply output, and the saturated magnetic amplifier that supplies the rate reference during an acceleration period.

Since magnetic amplifiers cannot accept regenerated power, the equipments to date have been supplied with slowdown regulators. If the CEMF becomes larger than the reference for the desired voltage, a magnetic amplifier picks up a relay to apply a slowdown resistor across the bus. The slowdown resistor accepts the pumpback power until the CEMF decreases to the desired value, at which time the slowdown resistor is removed from the bus.

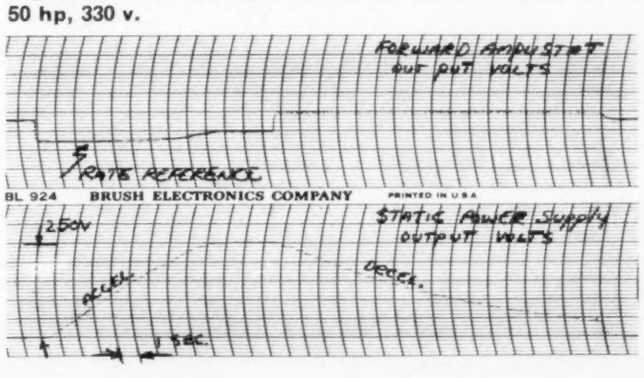
In addition to supplies for running the motors, rotating constant potential exciters are being replaced on some jobs by static supplies. Both regulated supplies for the regulator fields, and unregulated supplies for the relays, contactors, brakes, etc., are being used.

Static power supplies are being supplied in packages that are completely pretested and adjusted. This will reduce installation and maintenance time and expense.

SUMMARY

One of the prime factors that has contributed to the over-all performance of continuous processing lines has been a number of recent advances in the control systems. This has been possible because of the availability of new tools. The use of static components and new techniques have made the control system easier to install, tuneup and maintain. Increased accuracy and flexibility have resulted. The over-all system performance has been improved because the operator has more precise and reliable control of the process. ▲

Figure 12 — Recording of static d-c power supply, rated 50 hp, 330 v.



Pictorial Review

AISE Annual Convention and Iron and Steel Exposition

Cleveland, Ohio

September 23, 24, 25, 26

The board of directors, District Secretaries, and the AISE staff gathered for dinner (1) on September 22, preceding the official opening of the Annual Convention and Exposition.

Registration (2) brought the usual lines in the lobby of the Cleveland Public Auditorium. A total of 13,673 registrants attended the four-day meeting.

Authors and chairmen met each morning to discuss arrangements for their particular technical session. Shown in (3) are members of the Combustion Session: Seated are J. D. Wells, A. E. McDonough, T. J. Harrison and R. W. Worley. Standing are G. H. Krapf, R. H. Gherst and G. L. Rogers. Mechanical Session members are shown in (4): R. A. Kraus, R. F. Armitage, S. W. Stouffer and R. L. Rectenwald. Members of the Rolling Mill Session are shown in (5): R. W. Barnitz, H. H. Shakely, R. P. Schuler, Leonard Eller, Louis Moses and Dieter Hancke. Lubrication members (6) included H. J. Foster, P. D. Metzger, E. J. Hochdanner and A. E. Cichelli (seated), and F. M. Roberts and C. T. Lewis. Combustion Session members are shown in (7): F. C. McGough, David Cousley, H. S. Hall, E. T. W. Bailey and C. W. Dunn.

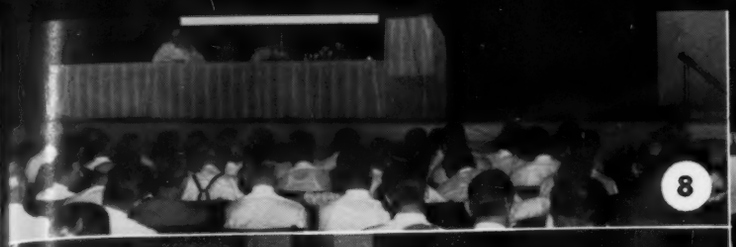
Technical sessions were well attended. Group shown in (8) are listening to Dieter Hancke's paper "Recent Developments in Pipe and Tube Mill Machinery."

The Iron and Steel Exposition utilized the largest amount of floor space in its history, and attendance and interest was high as shown in figures (9), (10), (11), (12) and (13).

Shown at the reception for Speakers' table guests, which preceded the banquet, September 25, are (14) A. L. Glossbrenner, President, The Youngstown Sheet & Tube Co., Leonard Larson, AISE President and T. F. Patton, President, Republic Steel Corp. In (15) are H. L. Jenter, vice president—operations, American Steel & Wire Div., U. S. Steel Corp., Emil Kern, vice president—engineering, Allegheny Ludlum Steel Corp. and E. R. Johnson, vice president in charge of operations, Republic Steel Corp.

Leonard Larson, AISE president (16) presents keys to the Ford Thunderbird to J. E. Sanderson, Electro Metallurgical Co., who held the winning ticket, drawn on September 26 at the close of the Exposition.

A portion of the 1200 people who attended the banquet, Thursday, September 25 are shown in (17). Emily Kimbrough, noted authoress, was the guest speaker.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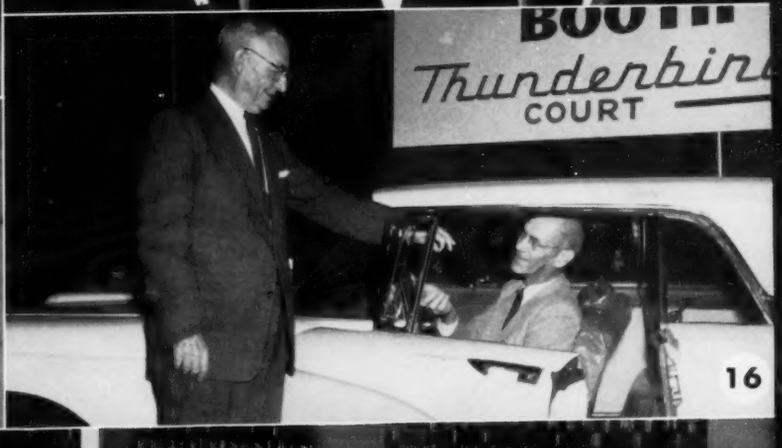

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Prize Winning Papers Announced At Banquet

△THE AISE Kelly Award prize-winning papers were announced at the formal banquet at the 1958 Annual Convention in Cleveland, Ohio, on September 25. First place was given to J. J. Murray and Thomas C. Graham for their paper "The Design of Mill Buildings." This paper which originally appeared in the February, 1957, Iron and Steel Engineer, gives a design procedure which can be used as a basis for building steel plant buildings, a specialized field in which there is much difference of opinion and inadequate data. Procedure developed by the authors is based on a number of tests made by them. Mr. Murray is a development engineer for Jones & Laughlin Steel Corp. and Mr. Graham is chief design draftsman in the design engineering department of the Pittsburgh works.

Herman E. Muller, superintendent, roll department, Inland Steel Co., Indiana Harbor Works, won second place for his paper, "Roll Pass Design for Combination Structural and Wide Flange Beam Mills." The paper describes how Inland combined the rolling of wide flange beams with the units that comprised their standard structural mill facilities. The paper covers the methods of rolling and roll design as they were established by the mill modernization program. This paper appeared in the December, 1957, Iron and Steel Engineer.

Third place went to John Simon, lubrication engineer, National works, National Tube Div., United States Steel Corp., for his paper on "High Temperature Steel Mill Greases." This paper describes tests and procedures which have given better results in high temperature mill applications. The paper was originally published in the June, 1957, Iron and Steel Engineer.

Authors of prize winning papers are shown with their awards. Left to right, they are John Simon, third place winner; and Thomas C. Graham and J. J. Murray, co-winners for first place. Absent when the picture was taken was Herman E. Muller, second place winner.

Because of the large list of excellent papers which had appeared throughout the year in the Iron and Steel Engineer, there were many suggestions for the prizes. Some of the other authors who received honorable mention and were close runner-ups are: E. N. Archibald, assistant superintendant, cold reduction dept., The Columbia-Geneva Steel Div., United States Steel Corp. for his paper on "Modern Techniques in the Cold Reduction of Sheet and Tinplate"; C. W. Dunn, superintendent, utilities department, Fairless Works, United States Steel Corp., for the paper "Fuels Contribution to Increased Open Hearth Capacity"; and L. A. Fugassi, assistant chief engineer, Weirton Steel Co., Div. of National Steel Corp., for his paper, "Weirton Modernizes Its Hot Strip Mill."

The Kelly award carries prizes of $300, $200, and $100 for the first, second and third place respectively. The award was established in 1943 to honor John F. Kelly, managing director of the AISE from 1917 to 1934, and to perpetuate the memory of his achievements in the advancement of the Association.

The award is made each year by the board of directors of the AISE upon the recommendation of the editorial and executive committee of the Association.

Rules of the award:

1. The award shall be given annually to the author of the paper, adjudged of greatest value in the advancement of engineering or operating practice in the iron and steel industry.

2. The entries for each judging shall be the papers published in the Iron and Steel Engineer during each calendar year, although some may have been presented at meetings in the previous year.

Voluntary contributions of papers not presented at meetings but published by the AISE are also included in the judging.

3. To be eligible for the award, the author must be directly employed in the iron and steel producing industry. The author need not be a member of the Association of Iron and Steel Engineers.

4. The award shall be made at the annual fall meeting following the close of the calendar year.

5. The award shall be made by the board of directors of the AISE on the recommendation of the executive committee of the AISE. ▲

Planned Maintenance Techniques For A Hot Strip Mill

by James R. Kennedy,
Maintenance Foreman,
Hot Mill Mechanical Dept.,
Pittsburgh Works Div.,
Jones & Laughlin Steel Corp.,
Pittsburgh, Pa.

Planned maintenance functions most smoothly when operating departments properly use equipment, maintenance departments perform constant inspection and correction and finally the designer produces units which minimize the burden of the operator and the maintenance man.

IT has not been too many years ago in our steel industry that such a thing as planned maintenance was an oft-discussed, ne'er-do subject that was only the figment of the wildest dreams of the men in the maintenance department. The word "maintenance," was a vulgarism to the people in the operating department and one that should never be discussed in public. The mere stating of the word created a mental image of an ungainly character, dressed in the latest fashion from "hobo jungle," who removed worn and broken parts of machines and replaced them with new ones, providing such parts happened to be available. Should they be unavailable, it became the maintenance man's responsibility to create a replacement part with nothing more to work with than his ingenuity and odds and ends from the scrap pile. The maintenance man is still today quite frequently "cussed" and sometimes "discussed"; he is criticized for poor engineering and design of equipment and is blamed for most delays in production; he is held responsible for over-spending, but seldom praised for any savings, either direct or indirect. Although he usually is not allowed to establish his own budget figure and must care and provide for the wants and wishes of nearly everyone on the company's payroll from the money allotted to him for maintenance purposes, in short, he is the root of all evil and the cause of all that is bad. Yet, is it not amazing, that for all that is deemed unfit about the maintenance man, his presence is ever-reflected and ever-necessary in the growth and development of American industry everywhere?

Why is this so, you may ask! In reply, you might ponder this statement of fact. The chief cause of taxes in this country is *government*, and by the same line of reasoning, it can be truthfully stated that the chief cause of maintenance is *usage*. If there were no government, there would be no taxes, and if there were no usage, there would be no maintenance required.

Webster defines maintenance as the act of keeping or holding in any given condition, especially, in a state of efficiency. We most commonly apply this term to buildings, structures, machinery, piping, roads, vehicles, wiring, the human body, etc., in our everyday use of the term.

Maintenance requirements are stimulated by scores of causes, among which, can be listed such items as:

1. Corrosion of metal parts
2. Rotting of wood, fabrics, synthetics, etc.
3. Disintegration of earthen parts, such as mortar, brick, stone.
4. Friction which is ever-present wherever two or more adjoining parts have motion.
5. Fatigue of members due to over-stressing, overheating or over-use.
6. Wrecks in which there may be one or more of the above causes present, or where carelessness or improper operation of equipment is the contributing factor.

The list could be extended to infinity, but the end result is always the same, that is, maintenance always results from a cause.

All here must readily agree that the fundamental reason for the establishment of a business, any business, be it large or small, is to realize a profit for the person or persons who have invested their time and money to open the business. American enterprise, having been established as a free system by our founding forefathers and guaranteed by the laws of our land, provides a competitive system in which it is well nigh impossible for a business to be established and be the sole supplier of a marketable item of consumer demand. The possibility of making a profit from a business by monopolistic methods is therefore eliminated, and the businessman must be able to produce his wares at a competitive price. In other words, the cost of producing any item of manufacture must be controlled if the business is to

make a profit. With the advent of large businesses, it has become a matter of common knowledge that the greatest profit is realized when the product of the business is produced at a high rate, and the cost of such production is kept under proper control. For the achievement of both of these goals, it is necessary that producing units be kept in practically continuous operation. When a unit is idle, production naturally is at a standstill. If a unit is idle because of a breakdown, it means also that extra costs are being added and the control of production cost is interrupted. Operating personnel stand around idle, utilities continue to be used, fuel is being consumed at approximately the same rate that it is used during full operations, while nonproducing overhead continues to accumulate.

Maintenance people everywhere realize that a very large percentage of the responsibility for the realization of profits for their company's business has been placed squarely in their hands. In order to accept this responsibility properly, the maintenance man today must, of necessity, establish and utilize a systematic program for the planning and development of his company's maintenance needs.

The first step in the development of a planned maintenance program is the need for a clear cut definition of the function of the maintenance department. In order to provide maintenance repairs and services, it is first necessary to have spare parts and adequate supplies. Anyone who has ever driven an automobile knows this to be true. Why else would the majority of us take our automobile to a dealer's service shop when it is not functioning properly? In order to provide good maintenance repairs and services, a sound policy of spares control must be a priority item on every company's system of maintenance. The maintenance department must be able to justify the reason for spending money that must necessarily be taken from the company's profits. On the other hand, the operating department must have some kind of defense against reckless stockpiling of many useless items of maintenance inventory by a maintenance man who still believes that every piece of equipment under his jurisdiction must be replaced in kind and number.

The keeping of records of past history of repairs made to operating units is a vital contributing factor toward a sound maintenance program. From these records can be determined approximate operating hours that can normally be expected before failure of vital parts occurs. Then too, if failures occur too frequently before normal life expectancy of parts is reached, under normal operating conditions, a warning signal is flashed before the wide-awake maintenance man that other conditions are taking place which require his immediate attention. Armed with the record of past performance of a given piece of equipment, adequate prior arrangements and plans can be made to remove the unit from service before breakdowns take place. Let us add here, that when we say breakdowns in this case, we are referring to breakdowns that would naturally occur due to excessive use and/or inadequate maintenance on the particular unit rather than the breakdown that occurs without warning or indication that any malfunction of the equipment is present. Thus, by being able to schedule downtime on the unit, material savings are realized in several ways:

1. Production schedules can be altered accordingly so that any or all other producing units that may be affected by scheduling any single unit down can be utilized to their fullest extent without experiencing undue delay.

2. Maintenance jobs scheduled ahead of time can be properly planned. If the repair job is of sufficient nature, that is, one requiring more time than is normally available in routine scheduled maintenance down turns, meetings between production personnel and the various maintenance crafts involved in the repair should be held. The importance of these meetings should never be minimized or eliminated as they form the basis upon which procedures for the repair should be established. It is in the procedures meeting that the possibility of conflicting work functions of the various crafts can be properly planned and allowances made for the proper tie-in of these functions so that all involved will be able to do their job with adequate time for each step, and still prevent the necessity of having excessive work forces on the job unable to perform their duties. It is in these procedures meetings too, that the suggestions of foremen and crew leaders, who in the main, are the people who are nearest to the actual performance of the work functions and operations to be performed, can inject their opinions and suggestions on the procedure being formulated. Most of the time, it is the utilization of these suggestions that allow for the repair job to be executed quickly and more efficiently.

3. Excessive and costly delays can be eliminated, or at least minimized and controlled, by the proper scheduling of maintenance repairs, rather than continuously running the unit until the breakdown occurs. It stands to reason, that if a unit is removed from service prior to an anticipated breakdown, serious wear and breakage on nonreplaceable parts will not occur. Bushings or wear plates, for example, which are removed and replaced before they are allowed to wear through the walls and into the metal of the nonreplaceable part, will prevent the necessity of having to weld and remachine or use over-size parts for replacements.

4. Workers' morale is materially improved whenever they know that their work has been scheduled in advance, thus minimizing the possibility of jumping from one breakdown to another. It is an indication of intelligent leadership, and commands the respect of the working man, who will always work more effectively when he can see that he is keeping ahead of trouble, rather than consistently being in the unenviable position of always having his back against the wall.

5. By eliminating the disruption of machine shop and other service department schedules, another very substantial saving can be realized. Personnel in the general service departments are no different in their dislike of being jumped from one job to another than is the man in the mill. A machinist who has his lathe set up for a scheduled machining operation must tear down the setup for an emergency job and then reset the scheduled job; a fitting aisle must be turned "topsy-turvy" for an emergency and then returned to some semblance or order; bricklayers working on a scheduled repair for a slab heating furnace get an SOS to go to a hot furnace job in the open hearths. Put yourselves in these men's places and what would be your reaction when this happens as a matter of course, rather than emergency?

Your reaction would be much the same as that of these people. They become unhappy and do not perform their best work. The man whose scheduled job was set aside in order to handle the emergency raises a fuss because the delay may put him in the same predicament and eventually cause emergencies in his department. Finally, the department where the emergency work is being performed pays a penalty price for the job, usually in the form of overtime hours and sometimes in the form of poor workmanship by disgruntled workers. Every emergency job means that the job in the machine must be thrown out, and all of this adds up to extra cost, and then for all parties involved in the breakdown, the work changes from that being performed on an organized plane to one of confusion, disorderliness, and at times near hysteria.

A very big assist in a well organized planned maintenance program comes from, of all places, the operating department. Granted, it may be difficult to achieve in some instances, but in such cases, it is our belief that there may exist a basic misunderstanding of the other fellow's reasons for apparently not showing signs of co-operation. Remember, you probably appear as unwilling to help him over a tough spot as he appears to be unco-operative with you. How does the operating department help in a planned maintenance program? Simply this, by training the operators to use the equipment, but not to abuse it. When carried out in all phases to all personnel involved and by making them understand that chance-taking, carelessness, and laxity on their part, sometimes even ignorance in order to make a higher production rate for themselves, is only harmful in the long run, unwarranted delays and expensive repairs can be avoided. All machinery is designed for certain normal duty, within given limits, as dictated by experience. Deviation from that duty or overloading the equipment is bound to produce undesired results. We all are acquainted with the automobile driver who comes up to a red light at 50 mphr and then stops on a dime. When the light changes to green, he gives his car the gun and puts a lot of extra strain on everything that comprises the structure of his automobile. One of life's biggest mysteries to this gentleman is just why is his automobile in the shop for repairs so often and why are his repair bills so high. Did he not buy the largest, most expensive and most highly-rated car on the market? Does he not have the most advanced automatic high torque transmission with a 400-hp engine and a 12 to 1 compression ratio? The counterpart of this man is the craneman who swings a magnetically-held slab over the furnace charging table and bangs against the charging doors of the furnace; the roller who does not have his drafts set uniformly and overloads one stand because the adjacent stand is not carrying its proper load; the heater who sends down an ingot with a cold butt, or a billet or a slab that is not uniformly heated the operator who allows two sheets to go into the leveller when there is room for only one; or who pulls a twisted strip into the coiler with the same speed as he would coil a uniformly heated and smooth flat strip.

While these improper operations are not carried out with any deliberate attempt to curtail production or damage equipment, but are rather the products of ignorance and carelessness, the delays are just as irritating and costly as if they had resulted from a bona fide cause. Some men do not appreciate the damage that can result from these improper operations because they have not been properly trained and instructed. Often times the evil results of malpractice may not be immediately evident. A piece of cold steel may be rolled without any immediate evidence of ill effect, whereas a crack may have been started in a piece of equipment that will result in its failure some time later.

A vital link in the chain of any planned maintenance program must be provided by the equipment inspection system of the maintenance department. There are many ways by which an inspection program or system can be carried out, but the success of any system depends in the main on the following:

1. Thoroughness of inspection.
2. Complete inspection coverage of all units.
3. Properly timed inspections.
4. Accurate and complete recording of all inspection data.
5. Skillful diagnosis of inspection reports.
6. Prompt and systematic scheduling of repairs indicated by inspections.
7. Good housekeeping.

We make use of these inspection system points at our plant in the following manner:

In order to assure ourselves that the first and second points in this system are controlled to a practical degree, the repairman for the hot mill and the repairman for the run-out table, coiling, and plate handling equipment make use of a printed inspection report listing all units that are under his maintenance responsibility. It is the repairman's reponsibility to submit one of these completed reports to his turn foreman on each turn that he works. Working three shifts a day, as we do, you can see the advantage derived here. What one individual may miss, either by laxity or lack of opportunity to inspect, one of the others will pick up and record.

The third point in this system must be established by supervision dictated by existing operating conditions and special problems peculiar to his particular installation. As an example of this, the measurement of wear on the teeth of our main mill drive gears can only be successfully accomplished during extended shutdown periods. Since these shutdowns only occur twice or three times a year, inspection of this item is planned to take advantage of the extended shutdown period.

Points four and five in this system are the responsibility of maintenance department supervision. It goes without saying, that if even in the simplest of recorded inspections, no mention is ever made of the condition of known check points, and such reports are permitted to continue by the supervisors, then failure to uncover or be informed of existing conditions cannot be attributed to a weakness in the inspection system.

Item six is materially aided by the fact that each week, the department superintendent of our plant holds a meeting with all sub-department general foremen and maintenance department heads, in order to discuss new ideas, check on the progress of existing improvements being installed into the physical make-up of the department and to determine if additional down time might be necessary, either immediately or in the near future, in order to make necessary repairs and replacement to existing equipment. This procedure is further

developed by a weekly maintenance meeting held by the sub-department general foreman with the maintenance department foremen, in order to outline and review the anticipated repairs to be made during the next scheduled repair turn.

Last, but by no means the least, a good system for inspections depends on good housekeeping. It is in itself almost self-explanatory and we will dwell on its relative merits but for a moment here. To begin with, it is a well recognized fact that a neat and orderly place to work in is a much easier place to maintain. It is also much safer and more desirable, and from this standpoint provides an additional incentive for all concerned to try to do a better job, regardless of the task to which they may be assigned. Insistence in making good housekeeping a basic part of everyone's work day is a fundamental method of making every wage earner realize that he is a necessary part in the over-all picture of the company's operation.

To summarize briefly then, concerning "inspection," as used in a planned maintenance program, let us always remember that one of the prime requirements for the successful use of this weapon is that the inspection is made by competent people. Regularity of inspection is necessary; daily, by the man operating the equipment or by another employee assigned to this task; weekly, monthly, or at some properly established period by supervision. Thorough delegation of this responsibility is needed so that every item covered is essential. Neglect of some little item can result in a serious delay. It is absolutely necessary to eliminate any divided responsibility, because when that condition exists and a breakdown results, it is always a case of the one man thinking the other man covered it.

Inspection must be reported and recorded. Simple items are reported to the turn foreman, who in turn, either lists the job on the daily repair sheet, or takes immediate action to correct the condition, depending upon the gravity of the reported condition. If it is of such a nature that it is not necessary to interrupt operations, and can be prolonged until such time that production is temporarily halted, as in the case of a roll change, sufficient tools, manpower, and spare parts can then be assembled ahead of time and the repair can be made within the allowable downtime for the roll change, or at least minimize the amount of downtime by the amount taken for changing rolls. After the reported condition has been corrected, the item is marked off of the daily repair sheet and noted in the Foremen's Log. It is date recorded under the unit's maintenance history or diary. In making repairs on equipment and using inventoried spare parts, it is necessary for the turn foreman to submit a list of spare parts or material used on a spares report so that the inventory of such items may be readjusted on the spares file. It is a common failure among all line maintenance personnel to become somewhat lax at times in regards to this last mentioned item. However, it cannot be overemphasized as being just as important a phase of any repair made as was the bearing, shaft, roll, bolt, or whatever was used in making the repair. As mentioned previously in this paper, a sound policy of spares control must be a priority item on every company's system of maintenance.

After inspections have indicated the repairs will be of a major nature, the actual work of making the repairs must be organized. The necessary tools must be assembled and checked for condition and the spare parts checked for condition and measurements; the various phases of the job must be delegated to the various foremen and repairmen and should be discussed with these crew leaders. By this method, the job is most efficiently and economically executed. One of the prime requisites is that the foreman must know what material he has on hand and where to find it. This requires orderly records of spare parts and orderly storage of spare parts—hence, the importance of the above-mentioned spares report and good housekeeping is re-emphasized.

The detection and replacement of worn or broken parts is not the end of a good planned maintenance program. Every such part is, to the wide-awake and worthwhile maintenance man, but a challenge to find the basic cause of the trouble and then devise a proper solution for overcoming the cause. The first step in this procedure is to identify the parts most susceptible to failure and then determine accurately the cause of such failure. This determination is in some cases simple, and in other cases very difficult, and at times, it is only after several failures that the true cause is established. It is hardly necessary to say that corrective measures are effective only when the true cause of failure is identified.

Planned maintenance functions smoothly only when all parties involved in operations, maintenance and design of the equipment, realize that it is not a one-way proposition. Operating departments must do their share by properly using the equipment provided for their job, and not abuse it. Maintenance personnel contribute by constant detection and adequate correction of bad conditions, the designer, by producing the best available design in order to lighten the burden of the operator and the maintenance man. Integrating the requirements and the functions of these mainstays of modern industry provides the challenge and goal toward which the good maintenance man of today is constantly striving.

Discussion

PRESENTED BY

D. W. PEHL, Superintendent, Mechanical Maintenance, Kaiser Steel Corp., Fontana, Calif.

JAMES R. KENNEDY, Maintenance Foreman, Hot Mill Mechanical Dept., Pittsburgh Works Div., Jones & Laughlin Steel Corp., Pittsburgh, Pa.

HARRY SMOLEN, Assistant General Foreman, Youngstown Sheet & Tube Co., Indiana Harbor Works, East Chicago, Ind.

ROBERT H. GRAY, General Supervisor, Maintenance Planning, Homestead Works, United States Steel Corp., Munhall, Pa.

B. A. SHRIVE, Superintendent, Electrical Maintenance, Kaiser Steel Corp., Fontana, Calif.

JULIAN F. JOSEPH, Superintendent General Stores, Ford Motor Co., Steel Div., Dearborn, Mich.

D. W. Pehl: I was interested in the size of your mill which compares to our own strip mill, an 86-in. mill.

You talked on the normal life expectancy of machinery which we, as maintenance people, all try to estimate by fact and experience, which led me into the question of what system do you use to remind yourself, that a life expectancy is coming to a conclusion? That would tie in with the question I had on inspection, since you pointed out that you, as supervisor, decided whether it should be a daily, weekly or monthly inspection.

You further commented that you recorded all of your inspections and indicate later that you were using a history or diary on all the pieces of equipment. I was curious to know just how extensively you recorded these inspections. It has been my experience that if you do not carefully survey that practice you will become highly involved in paper work which clouds the issue quite heavily as to what you're trying to accomplish with it.

You indicated that you had a repairman working on the hot mill and one from the run-out table on and mentioned again a pump machinist. I was wondering if that was your normal crew for an operating turn.

Do you have any particular motivators to have your people do a better job of inspection? Naturally, the end result always helps, but I would appreciate any comment you have on that.

I readily agree, and very strongly, with your comment on the supervision, analyzing and following through on inspections when they are turned in. I do not believe there is anything more aggravating to our people than to turn in an inspection report with all sincerity and have it cast lightly aside by their supervisor. I think there is no way you can more quickly kill interest than that.

Of course your comments on good housekeeping were the last in your listing, and I think they tie in all the way through; if you accomplish that, you go a long way toward establishing good maintenance.

You, at the conclusion of your talk, spoke of a spares file. I assume that you, as maintenance people, are in complete charge of all your spare parts. I wonder if you would elaborate on that just briefly, as to whether you distribute that responsibility to your various supervisors in the unit, or store them in the mill, or what your general practices are.

Again, I want to congratulate you on your talk and say that those problems are certainly common to all of us.

James R. Kennedy: You questioned the size of our mill? It is a 96-in. hot strip mill. It is not limited to being just a sheet strip mill. We can and do roll plate.

With regard to normal life expectancy and how we attempt to determine it for the various units, I can only say that through the years of nearly every known condition of operation, the experience of some of the people sitting here together with their planning has much to do with the determination of normal life expectancy of equipment in our mill. However, it will change from time to time as the operating conditions of the mill become either overstressed or relieved, depending on the product mix.

I believe you will all appreciate that a 96-in. hot mill, or a 96-in. mill of any kind is used universally for many products of strip. All units get a thorough work out. There is a range where the mill can operate very efficiently and produce very economically. But there is also a tougher part, when wider material is rolled, it is then that the wear becomes more excessive.

We more or less have our key points, the tough points of maintenance and repair, tied down. It is only through experience that we know which has to be looked at and when. Some cases it is weekly, others monthly, and still others semi-annually. This is our method of determining inspection time.

As I pointed out in the paper, we use—and we feel it is fairly successful—a printed form, or guide, for the repairman or the crew leaders with which to inspect the equipment and report conditions, and we require them to be turned in.

Skipping down a bit, you asked how you can motivate better inspection systems? You have to coddle the personnel assigned to these tasks, you have to nag them, you have to threaten them—I think we are all familiar with these methods of obtaining the best results from our people.

How extensive are inspections recorded? Again I have to make a qualified statement, and say, certain equipment inspections are recorded very accurately. As an example of this, the inspection of the condition of our roll neck bearings, or backup roll thrust bearings, or the bearings on our backup roll necks. The conditions found upon annual inspection of units such as air compressors; the internal parts of air compressors; the conditions or measured amount of wear on our gear teeth on our main mill drives; items such as these, which are not easily accessible—and by easily is meant in the next day or two, or even within the next month or two, such items as these are watched very closely and an active record is kept on them. Of course, there are many things that are looked at and corrected on the spot. It is not recorded any further than in the diary of the unit as a repair having been made.

Our normal crew size for the afternoon and night turns involves about 24 men. This includes repairmen, helpers, oil system operators, boiler room attendants, welders, and so forth. They provide services for the operating department in the form of dressing rolls, operating the oil system, the reduction gear oil system, and having an operator at the air compressors, unloading cars of liquid fuel for the slab furnaces, and things of that nature. It is a fairly good-sized crew from a maintenance standpoint, but many, many of their functions are pure service and not so much repairs.

In our spares file we use a card system of recording number of spares, kind, description, disposition and general information concerning each and every item. Spares storage is accomplished within our plant. To the untrained eye, or to the stranger, it may appear quite haphazard, and it is not always as orderly as is desired, because it must be stretched out over a very large-sized area. We are limited in space for having neat and orderly spares storage right at the spot within the mill. Our larger spares are stored quite a distance away from the mill and must be hauled in by truck or railroad. Smaller spares stored within the mill, are usually stored in fairly decent, organized out-of-the-way rooms so that material is not scattered about. The responsibility for keeping these places in respectable condition rests with the turn foremen, who are assigned certain areas. It is their responsibility to see that the places are kept in good condition.

The operating department and the labor department and the maintenance department, all have the same responsibility as far as area assignment and condition of such areas is concerned. This way, it is not all pinned down to one department. It works out a little bit better that way.

Harry Smolen: How large an office staff do you have to handle all this paper work—typists, clerks, etc.

James R. Kennedy: We carry a complement of three clerk typists and a spareskeeper. Working five days a week, means that we have two of these people working every day, and all of them working at the same time on two days of each week.

Robert H. Gray: One thing I noticed in your inspections—you make a general statement of inspection. Do you perform any magnetic particle testing of your major equipment items?

James R. Kennedy: Yes we do. We magnetically test our spindles and our half-couplings or any large casting that we feel may be defective, or whose condition we are desirous of knowing before we store it away. We have our own magnetic testing device. Also, if it is desired to go further, we have the facilities at the Pittsburgh works to have the material internally checked by means of an ultrasonic gage.

B. A. Shrive: I would like to ask Mr. Kennedy if he still has separate electrical and mechanical foremen, or have you made any attempt to combine those two kinds of foremen?

James R. Kennedy: We still have separate foremen in the mechanical and electrical departments. There has been no attempt made to combine the two classes of foremen.

Member: You have not been able to find the right one?

James R. Kennedy: We have not found the exact blending point yet. We are working in that direction though, you might say, we are constantly trying!

Member: Do you operate under a budget? Do you have a whole force available? Do you have scheduled downturns for repairs?

James R. Kennedy: In answer to the budget, we do work under a budget. We must make a budget forecast for the following year by mid-November of the preceding year. We have, on our daylight turn, a full force available. We do have a scheduled downturn for repairs and in our case, it is Sunday.

Julian F. Joseph: To what extent does the maintenance department control spare parts? At what point do they reorder spare parts? Was there ever any consideration given to a central department controlling all spare parts for all maintenance departments?

James R. Kennedy: We have full control over our spares, both in size and in number. However, we stay within a range as designated by what we have established as being a maximum or a minimum number of spare pieces for any particular item.

With regard to centralized storage of spares, there is a small amount of it done at the Pittsburgh works with special attention given to things that are interchangeable, such as bearings, oil seals and the like. These items are controlled by a spares co-ordinator, who has access to all of the spares files, and maintains a record of all the spares files of every department in the works. He has the authority to veto an order, so to speak, if it is found or felt that other departments have more than adequate supply of such an item on hand, or that such an item can be readily picked up from another department. This prevents over-inventorying items in any given department.

Julian F. Joseph: Are the spare parts an inventory item or are they charged to expense on acquisition?

James R. Kennedy: The spare parts that we control are an inventory item. ▲

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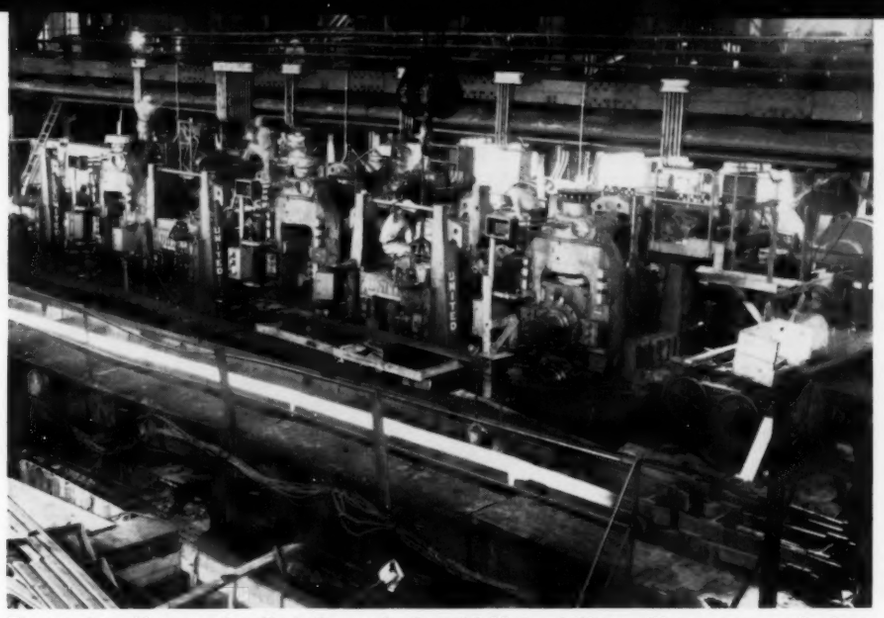


Figure 1 — Hot steel rolled through the old 28-in. billet mill as men worked on the new 30-in. six-stand mill at Pittsburgh Steel's Monessen works.

Pittsburgh Steel Completes 6-Stand, 30-In. Billet Mill

THE first steel was recently rolled out of Pittsburgh Steel Co.'s new billet mill. Construction of the new mill was completed in 20 days—one day ahead of schedule.

The $6,000,000, six-stand, 30-in. mill consisting of three horizontal mill stands alternating with three vertical sets of rolls was constructed in, around and under existing rolling facilities that maintained production-as-usual schedules in the Monessen, Pa., works.

Among the first steps taken several months ago was changing the power for the half-century-old, steam-powered rope drive to one of six 1750-hp General Electric motors designed for the new mill's sixth stand.

The new motor was put into temporary use to drive the second stand of the old mill by means of a gear reducer.

Meanwhile, the other five motors and the United Engineering and Foundry Co. mill stands and gear drives were installed as steel rolled on the old 28-in. mill built in 1908.

Pittsburgh Steel engineers and the contractor, F. H. McGraw & Co., mapped out their course of action for the estimated 21-day shutdown that began August 1.

Working on a round-the-clock basis, McGraw crews dismantled the tables, two stands, conveyor beds and shears of the old 28-in. mill that has produced steel for more than 50 years.

Then the new mill was constructed over the foundations and oil cellar that had been completed while the old mill was still in operation.

Entry, transfer and delivery tables were installed. The temporary drive motor of the 28-in. mill was relocated to drive the sixth stand of the new mill.

The new mill's stands were designed to permit the rolls to be adjusted endways in addition to the normal roll adjustments.

With the new 30-in. mill in operation, Pittsburgh Steel is now able to increase the flexibility of its rolling, open hearth melting and steel handling schedules. It will roll blooms from 9 x 10 in. down to 4-in. squares as well as rounds for seamless tubes down to 4⅝ in. diam.

The entire expansion program of the billet mill is the final part of the $111,000,000 cost reduction plan that improves Pittsburgh Steel's competitive position in the market. ▲

Figure 2 — One stand of the old billet mill is shown being hoisted out of its bed at Pittsburgh Steel's Monessen works where a new six-stand, continuous billet mill began operation.

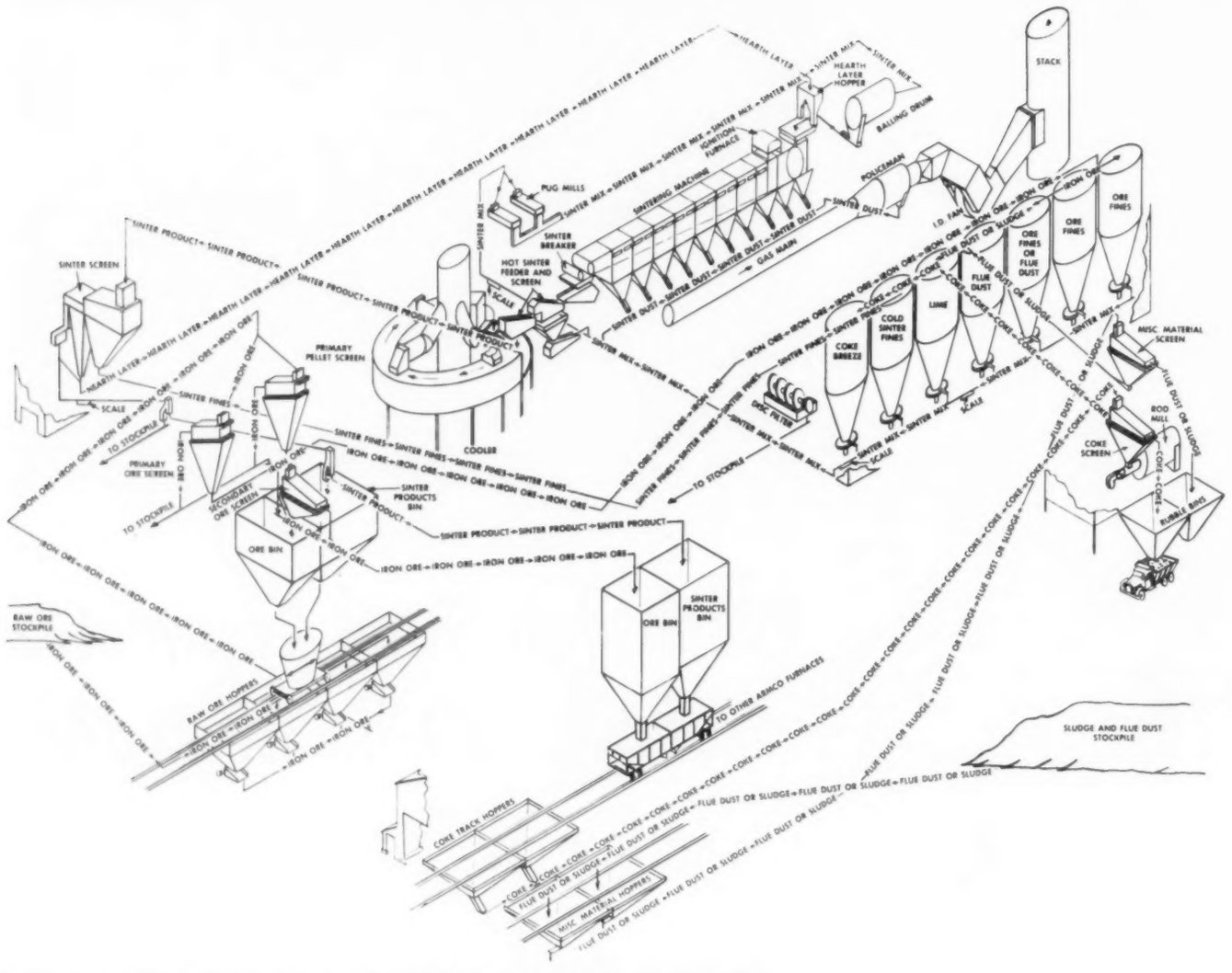


Figure 1 — Flow chart of sinter plant Ashland, Ky., works, Armco Steel Corp.

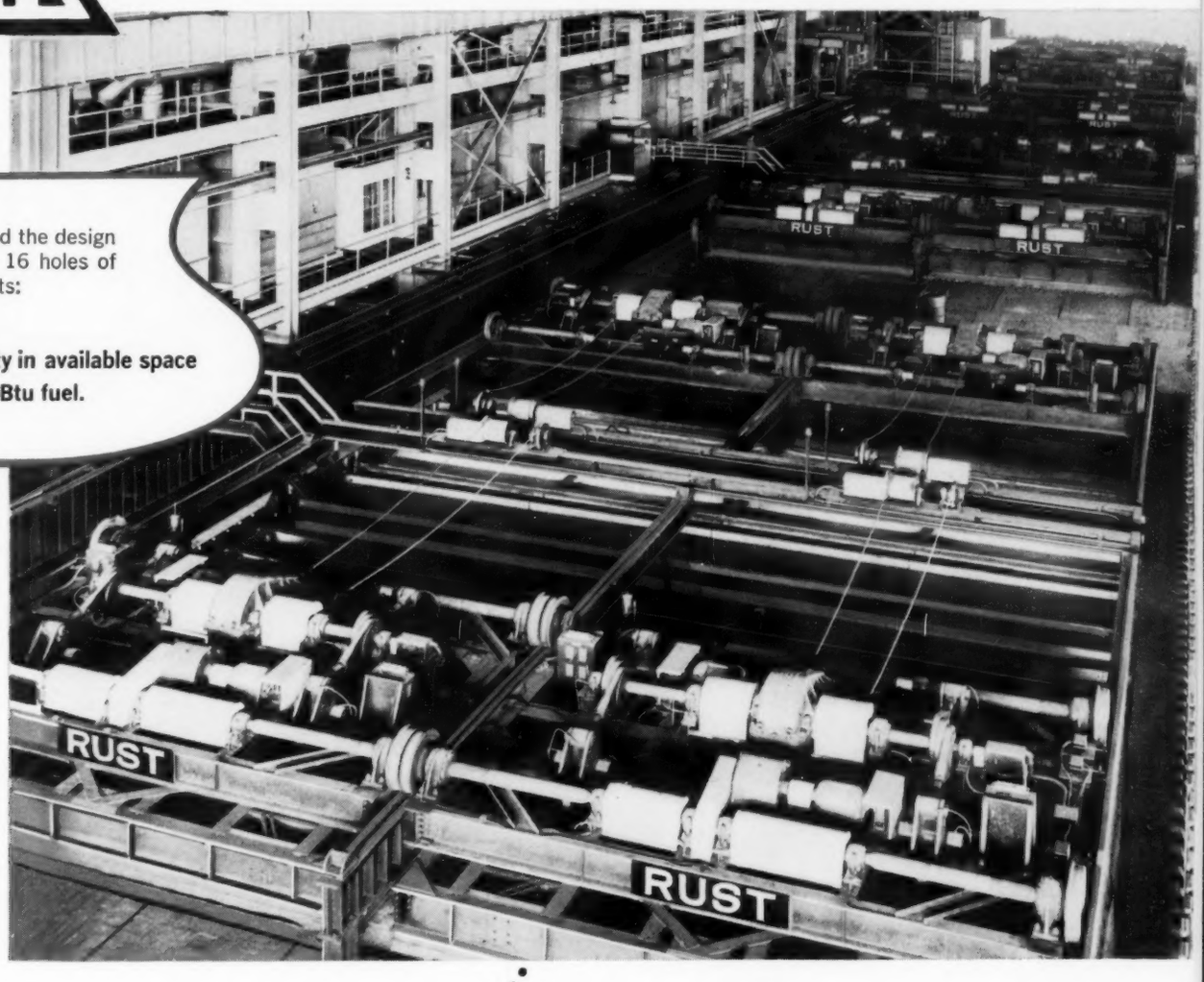
Armco Completes Sintering Unit At Ashland Plant

SINTERING facilities with an output of 2400 tons per day have been placed in operation at the Ashland plant of Armco Steel Corp. for the agglomeration of iron ore fines and other raw materials. Engineered and constructed by Dravo Corp. of Pittsburgh, this is the first plant to be built and placed in operation by the Pittsburgh concern under a license granted by the Lurgi Co. of Germany. Three other sinter plants are in various phases of construction by Dravo. One of 2000-ton per day capacity is undergoing shakedown operations at the Trenton, Mich., plant of McLouth Steel Corp. Two others of 15,000 tons per day output, rated as the world's largest, are nearing completion at Gary, Ind., and Saxonburg, Pa., for U. S. Steel.

Built primarily to agglomerate iron ore shipped in from Labrador, the Ashland installation will also be used to reclaim large stockpiles of flue dust and sludge which have accumulated during the past 16 years. These stockpiles are estimated to contain some 360,000 tons with an iron content of about 50 per cent, all of which can be

soaking pits

accelerate ingot capacity... even with low Btu fuel



Three requisites dictated the design requirements of these 16 holes of regenerative soaking pits:

1. **Quality heating**
2. **Maximum capacity in available space**
3. **Utilization of low Btu fuel.**

Island type layout employing eight batteries of two holes each was used for this specially designed installation at a large eastern steel mill. Pit size: 16′ wide, 20′ long, 10′5″ deep. Each hole has individual cover mechanism.

Completely modern temperature and combustion controls insure rapid, efficient heating with a high degree of uniformity from top to bottom and complete absence of washing.

Pits are cross-fired and each pit has primary checkers at the base of the downtakes and also secondary checkers at the base of ejector type stacks. The checker system preheats combustion air to approximately 2000°F. Each pit has two induced draft stacks equipped with automatic reversal systems enabling each hole to handle 35,000,000 Btu per hr. input of 106 Btu per cu. ft. mixed coke oven and blast furnace gas. Fuel rate for heating 3½ hr. track time steel is approximately 500,000 Btu per ton and 1,100,000 Btu per ton when heating cold steel.

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Figure 2 — New 2400-ton per day sinter plant at Ashland, Ky., will be used to agglomerate Labrador iron ore and to reclaim some 360,000 tons of flue dust and sludge accumulated during the last 16 years of blast furnace operations.

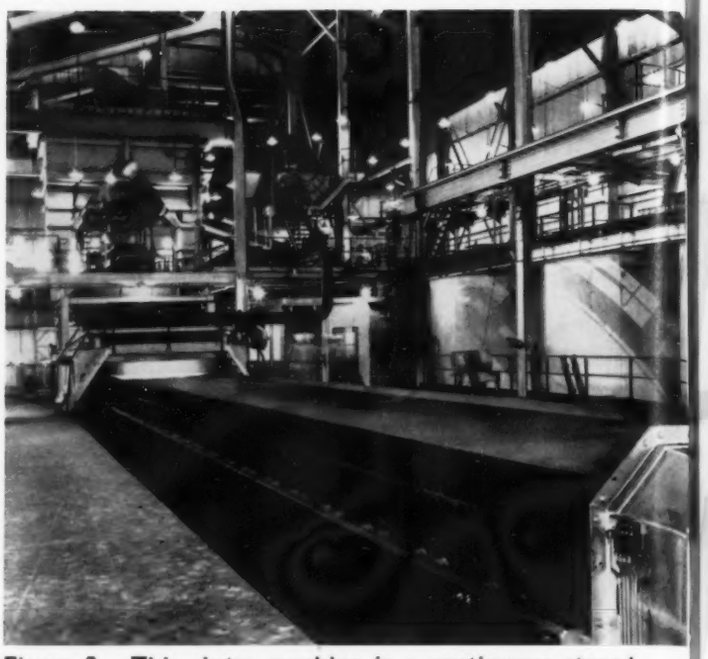

Figure 3 — This sinter machine is a continuous strand type, which may be regulated from 6 to 17½ fpm. It consists of 85 pallets, a hearth layer system, special ignition furnace and a new type of sinter breaker.

reclaimed by the sintering plant and converted into pig iron in the blast furnace.

When operating at full capacity, the sintering plant can process 876,000 tons of ore annually. Completion of the plant will provide the three blast furnaces at the Ashland works, with an ore burden that is entirely beneficiated. The burden will consist of taconite pellets, oversized Labrador ore and sintered ore.

In addition to the large savings from the reclamation of sludge and flue dust, additional savings may be expected, in the operation of the blast furnaces, from a decrease in the consumption of blast furnace coke and an increase in furnace production.

Additional benefits are expected in the open hearth operations. One of these benefits is a decrease in operating costs due to a higher production rate resulting from availability of more hot metal. Other benefits should result from reduction in purchased scrap and the possibility of substituting screened Labrador ore for expensive open hearth ore.

Equipment for handling raw materials is designed to receive and store a day's requirements in eight hours. Raw ore is dumped by furnace transfer cars into four hoppers under a high line and fed by vibrating feeders to conveyor belts. The belts carry the ore to primary screens of $^3/_8$-in. mesh. Fines passing through the screen are conveyed to raw material storage bins in the main sinter building. Ore passing over the screen may be directed to a storage bin over the high line for transfer to the blast furnace, to a bin over the yard level track for rail shipment to blast furnaces in other parts of town, or to a secondary ore screen where plus 1-in. material is collected for the open hearth.

Flue dust or sludge from the 16-year stock pile is received in two track hoppers at yard level, fed by belt feeders onto a conveyor and sent to a rubble screen. From the rubble screen it goes to another shuttle conveyor and into any of three raw material bins, one of which is a swing bin either for ore or flue dust. Miscellaneous materials such as limestone and mill scale will be handled over this same system when they are used.

A parallel set of track hoppers, belt feeders and rubble screen brings coke breeze to the rod mill, where it is crushed to a particle size of $-^1/_8$ in. Conveyors then take it to its storage bin in the main building.

The fourth raw material to be stored is the return cold sinter fines which has been screened out of the sinter and conveyed back to the bin.

Preparation of the raw materials for sintering is accomplished by a conventional pug mill and a balling drum. Fed onto a belt by 75-in. table feeders, the iron-bearing materials (ore, flue dust, return sinter fines) are totalized by a belt meter. A proportionate amount of coke is added and a second scale records the new total.

As the raw material is conveyed to the pug mill, several other materials are dropped on top of the mixture. The first of these is the sludge produced by a furnace gas cleaning system. The sludge has been settled in a 90-ft diam Walker thickener installed as part of the sinter plant project.

Slurry from the bottom of the thickener is pumped to a vacuum disk filter and deposited on the raw material belt as filter cake. Next to be added is the dust and accumulated spillage from the sinter machine, fed onto a dust belt from chutes and dust valves. Lastly the hot fines, falling through a vibrating screen that feeds the sinter cooler, are fed onto the raw material by a vibrating feeder.

Sufficient water is added in the pug mill to quench the hot fines and to promote proper mixing, after which the material is sent to the balling drum. Final adjustment to the mix is made in the drum with the addition of enough water to give the desired consistency and

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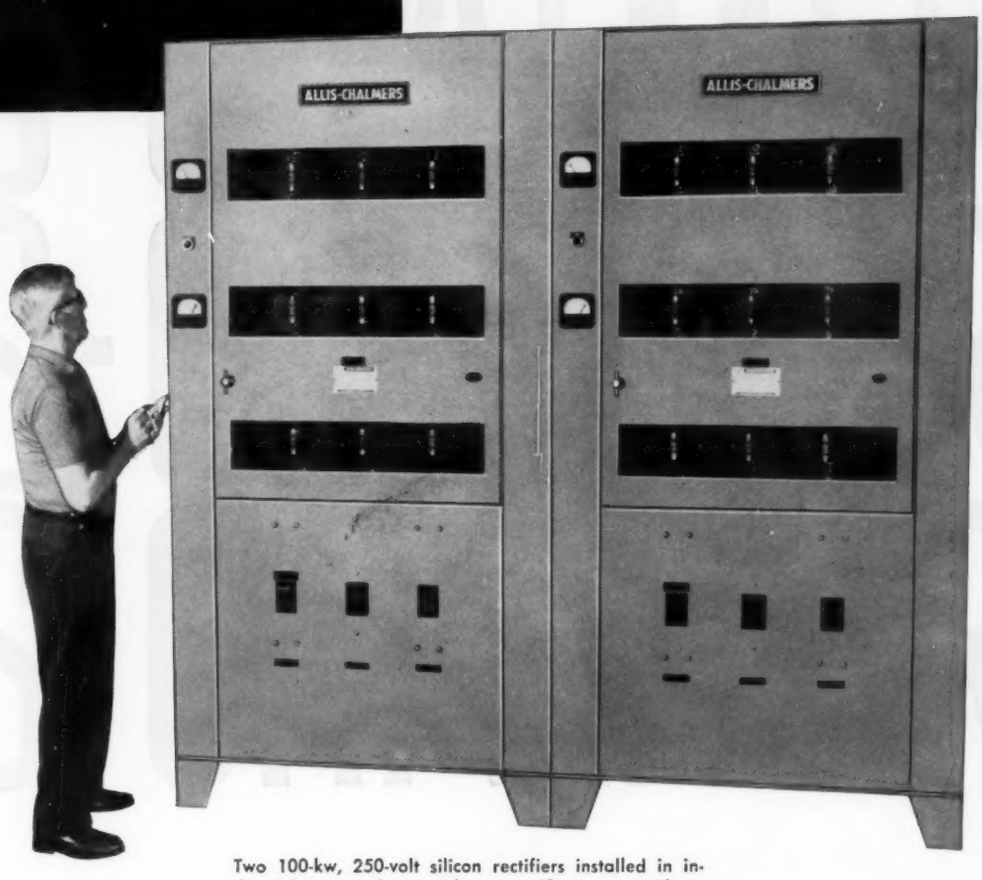

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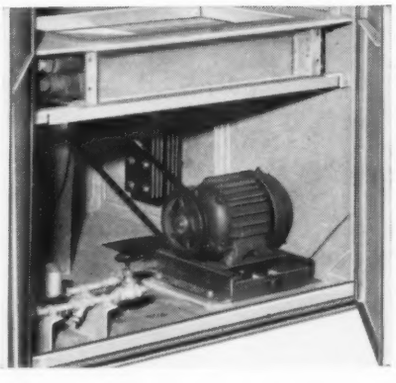

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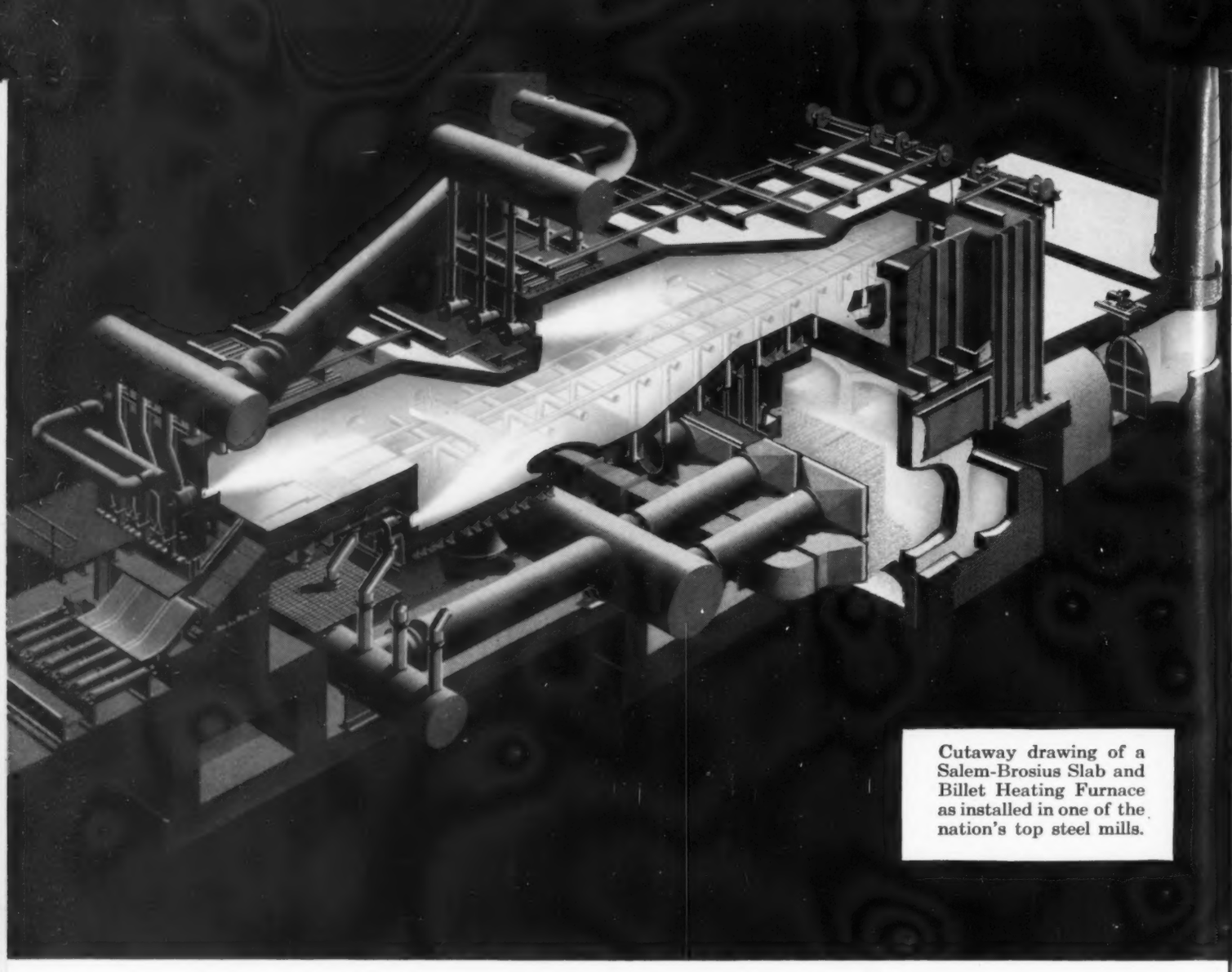

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pellet size. An equalized distribution of the various particle sizes in the mix onto the sinter machine is achieved by using an oscillating conveyor to carry the material into a trough or hopper over a roll feeder.

The Dravo-Lurgi Sinter Machine at the Ashland Works of Armco Steel Corp. is a continuous strand type, 8 ft-3 in. wide with a suction area of 807 sq ft. The machine length is 124 ft-7¾ in. from center of sprockets with a length over windboxes of 97 ft-8 in. It consists of 85 pallets in the top and bottom strands, a hearth layer system, roll feeder, ignition furnace, 15 windboxes, tipping wheel, adjustable drive gear train, and sinter breaker. The speed of the strand may be regulated from 6 to 17½ fpm.

The pallets are of one piece cast iron construction. Each pallet has four 8-in. diam chilled cast iron wheels which ride on tapered roller bearings on steel stub shafts. Each shaft has a lubricated roller which engages with the drive sprocket and tipping wheel, eliminating all contact between the pallet castings at both ends of the machine. The pallets have a renewable 5½-in. wide seal bar which acts with the lubricated seal bar on the windbox casting to form a tight grease seal.

The pallets travel along the top strand with the wheels rolling on a composite steel and rubber rail. Use of the rubber rail distributes the weight of the pallet so that part of the weight may be carried by the four wheels and part may be carried by the lubricated seal bars.

The grate is composed of three lateral rows of heat resisting cast iron finger type bars.

The discharge end of the Dravo-Lurgi machine has a patented tipping wheel designed to eliminate wear on the pallets as they travel from the top to the bottom strand.

The windboxes have flanged openings at the bottom to connect to Lurgi "S" dust collectors or multiclone type collectors. The windboxes bolt to rigid cast iron frames which in turn are bolted to the machine frame.

The hearth layer feeder consists of a structural steel hopper with a manually controlled adjustable gate for control of the hearth layer depth from ½ to 3 in. Both the hopper and gate are so designed that "stickers" can be passed without undue surges of hearth layer material onto the strand.

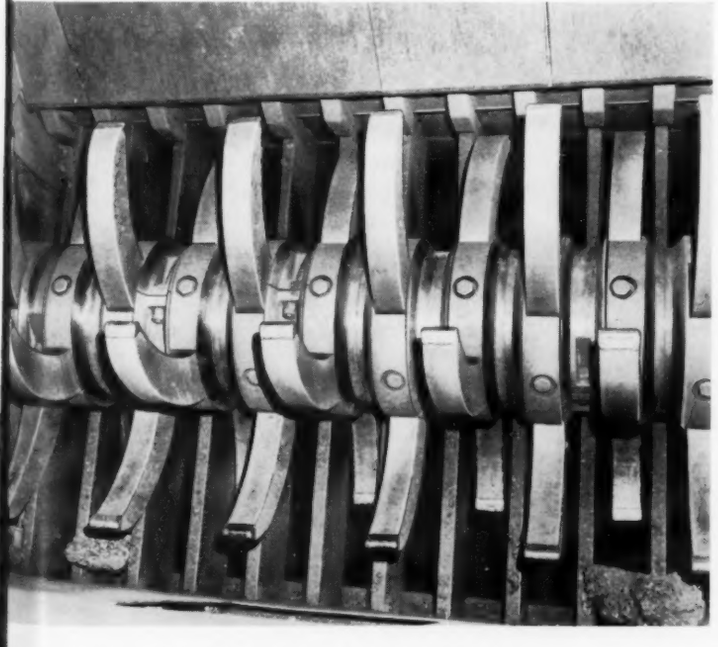
Sinter mix is fed onto the machine by a roll feeder. The feeder drum is 40 in. in diam and is driven by a 5-hp motor, the speed of which is electrically interlocked to the machine speed. Above the roll feeder is a small surge bin with a manually operated gate to control the height of material discharging from the roll. The strand bed depth is maintained by a manually operated adjustable cutoff gate.

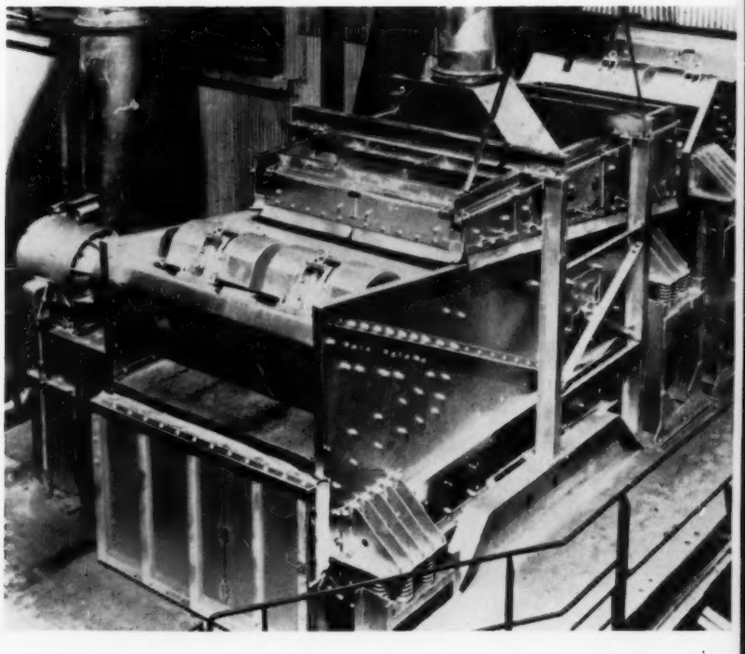
A feature of the Armco installation is the Dravo-Lurgi (patent applied for) sinter breaker, designed to reduce the sinter product to a size of minus 6 in. It consists of a six-sided shaft onto which are mounted renewable hubs and breaker arms. The breaker arms break the sinter cake through grizzly bars spaced to produce the desired size. These arms are made of mild steel 4-in. plate, hard surfaced at the critical cutting nose. A bull gear at the end of the breaker shaft is driven by a reducer powered by a 30-hp motor.

Speed of the breaker arm shaft is approximately five rpm. The entire discharge end and breaker assembly is enclosed in a hood from which air is exhausted into the dust collection system.

The ignition furnace consists of a welded steel shell containing a rammed type refractory lining and a row of special burners. The burners are located to provide a smooth sheet of heat over the entire width of the sinter bed. The burners are sized to provide up to 120,000 Btu per ton of final sinter produced. The bottom of the furnace is protected by an annular water-cooled

Figure 4 (left) — A feature of the Armco sinter machine is the sinter breaker, designed to reduce the sinter product to a size of minus six inches. It consists of a six-sided shaft onto which are mounted renewable hubs and breaker arms. Figure 5 (right) — The conveyor equipment, through mechanical "micro-thrust" vibrations, throws the sinter cake forward in a series of small parabolic arcs. The feeder is a freely oscillating unit, supported on multiple helical springs which prevent transmission of vibrations to foundations and platforms.





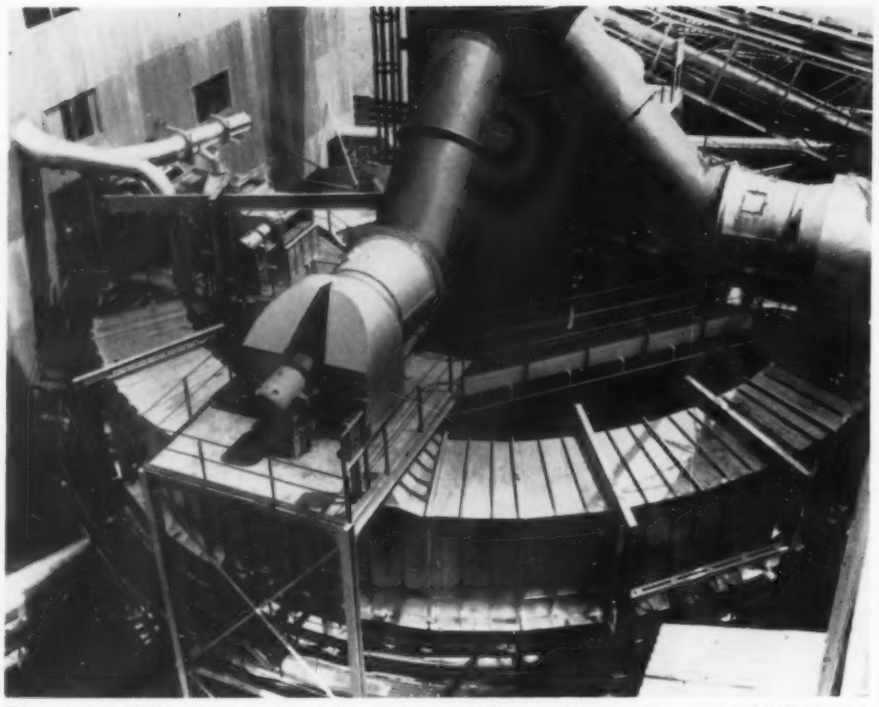


Figure 6 — Designed to air cool sinter product to a temperature at which it can be handled by standard rubber belt conveyors, this circular cooler has a mean diameter of 65 ft and a tray width of 7 ft. It is equipped with three fans, each with a capacity of 150,000 cfm.

jacket, and water-cooled adjustable gates prevent heat leakage at the ends. The replaceable furnace is mounted on a structural steel carriage which runs on rails parallel to the strand. The movable carriage makes the furnace accessible to an overhead crane for repair or replacement.

Lubrication of all main bronze bushings on the drive sprocket and gearing shafts, feeder drum, return shaft and breaker shaft is done by a central lubrication station. Signal lights and a horn, which indicates faulty pumping, are located in the vicinity of the central stations.

Two large Dravo-Schenck vibrating feeders and a vibrating screen are used to load the hot sinter onto the cooler. The vibrating screen serves to remove the hot fines and permit better cooling as the sinter travels around the circular cooler. Three fans draw 150,000 cfm of air apiece through the bottom of the 7-ft wide pallets and discharge it into a common stack as the material moves around at speeds up to 10 fpm. The cooled sinter is then dumped into a hopper from which a vibrating feeder loads a conveyor going to the sinter screen.

Three separations are made on the double-deck screen. The minus $\frac{3}{8}$-in. sinter is returned to a raw material storage bin, plus $\frac{3}{8}$-in., minus $\frac{3}{4}$-in. material, is used as a hearth layer and the plus $\frac{3}{4}$-in. sinter goes out as product. Provisions are made to regulate the amount of hearth layer material sent to the machine by using a flop gate to divert it onto the sinter product belt if the hearth layer hopper is full. In either case the product sinter goes to a storage bin over the high line for transfer to the blast furnace, or to a bin over the yard level railroad track for shipment to one of the other two furnaces.

To minimize the dirty conditions that usually prevail at most sinter plants, three separate dust collection systems were installed. The main system cleaning the ducts going to the sinter fan consists of five fly ash arrestor multitube collectors on the discharge and windboxes, ten Lurgi "S" type separators and one Lurgi "Policeman" type separator. This system is expected to clean the gas to 0.1 gr per cu ft or less.

The second system, a fly ash collector, picks up dust from the discharge end of the sinter machine, the hot sinter feeders and the cooler loading and discharge points. The third system, also a multitube collector, picks up dust at the sinter screen and several transfer points on the sinter handling system. ▲

How to measure

Now is the time to take a long, hard look

A continuous furnace is more than just a brick-lined structure built to heat a material; it is a processing tool.

Like all processing tools, it must be evaluated on an overall basis. Fuel consumption and efficiency may be completely outweighed by many more-important economic factors centering around your workpiece, your total production program, and your work force.

Your evaluation may well prove that an investment now in Selas continuous heat processing will bring immediate returns in reduced costs and improved product quality.

To help you take this long, hard look at your heat processing equipment or requirements, Selas offers these 15 evaluation factors:

- **Material handling**
- **Product value**
- **Material saving**
- **Fuel efficiency**
- **Automatic operation**
- **Temperature control**
- **Labor requirements**
- **Work in process**
- **Product quality**
- **Equipment flexibility**
- **Maintenance**
- **Production requirements**
- **Process coordination**
- **Floor space**
- **Human element**

The factual report on the facing page tells how a steel mill took this long, hard look at its bloom reheating. Every evaluation factor proved significant: one factor alone represented savings which equalled the cost of the entire Selas furnace line in 1½ months!

See Selas Heating in Action at the Metal Show Booth 1924

the real cost of continuous heat processing

. . . here's how one SELAS installation stands up under that "long, hard look!"

Conventional practice of reheating blooms had been to remove them from the rolling process, charge them into batch-type reheating furnaces, soak them for 60 to 90 minutes. Blooms were then taken from the furnace, placed back onto the rolling mill table for final rolling.

At least 2 handlings of steel by mechanical manipulator were involved. It is generally agreed that picking up hot steel, transporting it 100-150 feet and setting it down, costs $2 per ton.

Material Handling

Selas continuous heat processing has eliminated both handlings . . . saved enough to pay for the heat processing equipment in 1½ months!

Product Value

The value of the material passing through this furnace line in only 26 hours equals the cost of the entire heat processing installation!

Material Saving

Because reheating time is 3 minutes instead of the conventional 60 to 90 minutes at 2250°F, less scale is formed. This amounts to a saving of 3 tons of steel per hour—enough to pay for the continuous furnace line in only 5½ months!

Fuel Efficiency

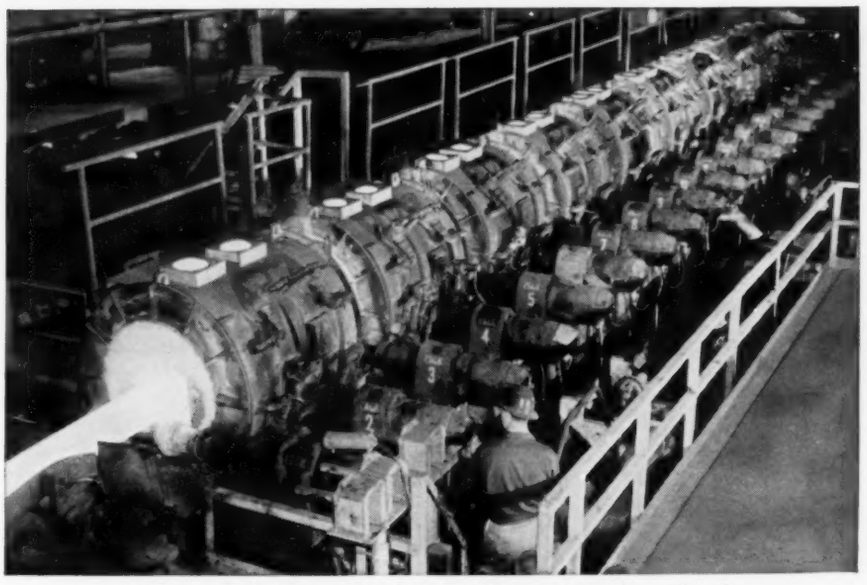
Fuel efficiency is not of major consequence because the total fuel cost is less than 0.6% of product value. Fuel efficiency could be increased through recuperation. Even if fuel efficiency could be increased by 50%, however, the cost of this additional equipment — plus higher maintenance — would add more to production cost than the 0.3% saved.

Automatic Operation

The furnace line accepts blooms at the charge-end whenever space is available in the furnace. Or, if no bloom is on the conveyor the furnaces automatically go on low temperature setting. Blooms, at optimum rolling temperature, are automatically delivered whenever required by the rail mill.

Temperature Control

Fast response of the Gradiation® furnaces permits accurate automatic control of bloom temperature. Uniform heating by radiant gas-fired Duradiant® burners produces optimum rolling temperature throughout every bloom.



Continuous Selas furnace line, located between a blooming mill and a rail mill, reheats blooms "on the fly," at rates up to 198 tons per hour.

Labor Requirements

None! Routine supervisory inspection of recording equipment is the total human contribution required.

Work in Process

Only 9½ tons of steel (maximum) need be in process to meet even the most widely varying production requirements. The previous method required 195 tons.

Product Quality

Reproducible metallurgical uniformity is achieved within each bloom and from bloom to bloom.

Equipment Flexibility

Furnace line heats blooms from 8 inches square to 11 inches square in cross-section, 8 to 22 feet long, weighing from 1744 to 9050 pounds each.

Maintenance

Simple, minimum. A stand-by barrel is quickly inserted into the line whenever major overhaul is necessary.

In 23 months of continuous operation, seven barrel furnaces have been re-lined, at a cost of only ⅔ cents per ton of reheated blooms. This is less than 0.007% of the value of product passing through the furnace line, and amounts to but 1.03% of the total original equipment cost.

Production Requirements

The furnace line can handle up to 198 tons per hour according to fluctuating demands of the rail mill.

Process Coordination

This continuous Selas line is an integral part of the roll conveyor between the blooming mill and the rail mill.

Floor Space

Valuable floor space was saved through Selas fast heating. This entire furnace line occupies only 63 x 11 feet.

Human Element

Automatic control and operation completely eliminate variables in product quality due to the human element.

* * *

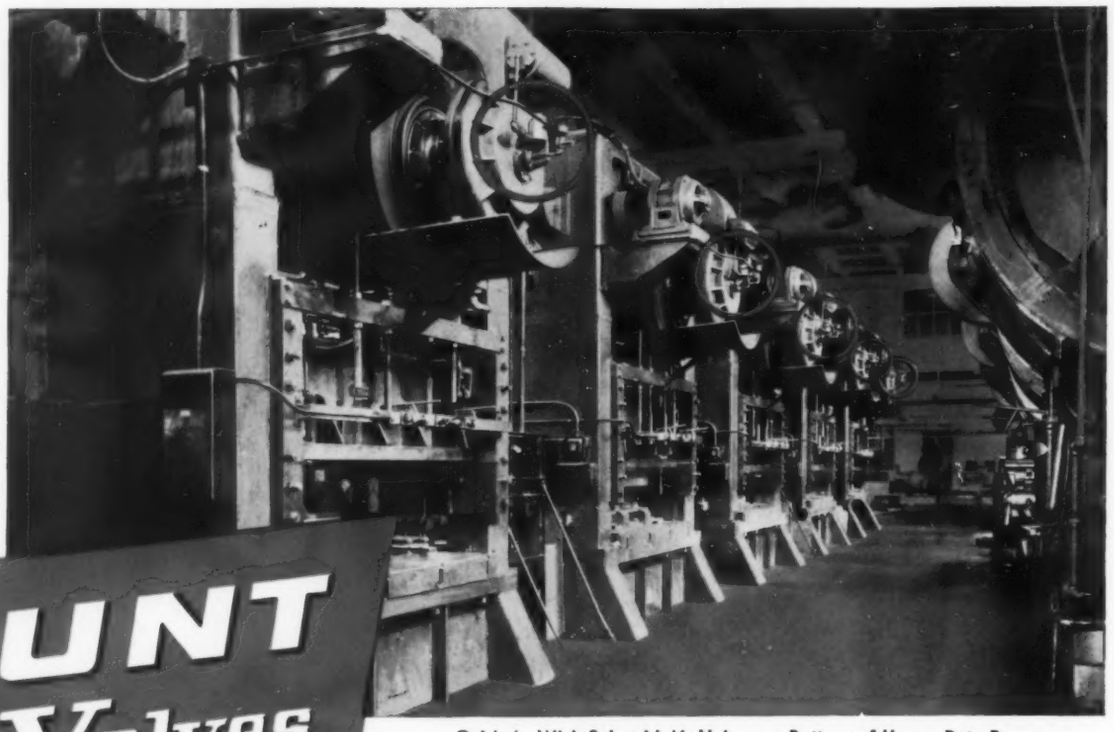
For case histories covering other steel mill heat processing operations, as well as heat treating, heating for hot working and brazing, send for reprint "An Economic Appraisal of Continuous Heat Processing." Address Dept. 410, Selas Corporation of America, Dresher, Pa.

Gradiation and Duradiant are registered trade names of Selas Corporation of America.

SELAS CORPORATION OF AMERICA DRESHER, PENNSYLVANIA

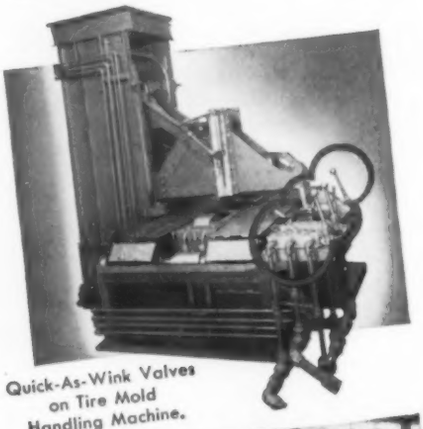
Heat and Fluid Processing Engineers

DEVELOPMENT • DESIGN • CONSTRUCTION



Quick-As-Wink Solenoid Air Valves on Battery of Heavy Duty Presses.

HUNT CONTROL Valves



Quick-As-Wink Valves on Tire Mold Handling Machine.

Quick-As-Wink Valve on 8-spindle Automatic Chucking Machine.

proven dependable operation

no after hours Siss-s-s-s

That harsh sizzling noise you hear out in the plant, after the work force has gone home, is there during the day also. Only you can't hear it then. It's air, seeping out through inferior valves, wasting from $5.00 to $500.00 per month. And leaky valves mean sloppy machine control; danger of "repeating"; possible injury to the operator; or a breakdown involving costly repairs, material spoilage, lost production and customer ill-will.

Stop the s-i-z-zling by installing Hunt valves on all your air and hydraulic controls. Positive and fast-acting Hunt valves are designed and built to seal tightly, preventing leaks, and minimizing the danger of breakdowns and tie-ups. Sizes from ⅛″ to 8″. 29 Hg vacuum to 250 p.s.i.; up to 5000 p.s.i. on oil and water. *Zero leakage.* Recognized by operators, foremen and superintendents everywhere for unsurpassed economy, low maintenance and long, efficient service.

HUNT

Quick-As-Wink® AIR AND HYDRAULIC CONTROL Valves

Manufactured by HUNT VALVE COMPANY, 1921 East Pershing St., Salem Ohio

Joy Enters Iron Ore Beneficiating Field With High Tension Separator

THE problem of economically beneficiating iron ore may be solved by high tension separation, and this new development forms the basis for Joy Manufacturing Co.'s expansion into the minerals dressing field. This expansion is the result of a working agreement between Joy Manufacturing Co. of Pittsburgh, Pa., and Carpco Research and Engineering, Inc. of Jacksonville, Fla., whereby Joy can manufacture and sell Carpco's high tension separator to the iron ore industry.

The process, a development since the war, has given extremely successful operation in some nonferrous ores, particularly for titanium, columbian and tin. In Malaya alone there are over 84 plants primarily on tin, and it is claimed that they have paid for themselves within five to six weeks.

The process is not complicated and necessitates the use of relatively simple equipment. It is a dry process thus eliminating the need of developing large supplies of water. Weather is eliminated as a problem, and, therefore, the technique has advantages in places, such as in Canada where processes using water cannot be operated at times when the ore would freeze.

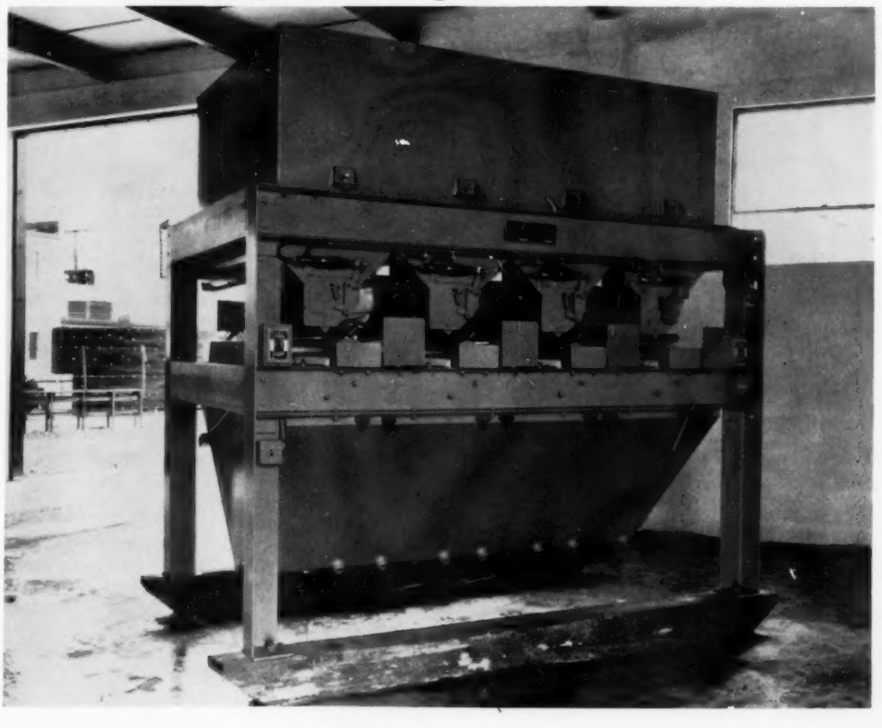
In essence, the process is dependent on differences in conductivity between the ore and gangue from which the ore must be separated. In the process, pulverized, raw ore is dropped down over a rotating roll against which there is a corona discharge from a high voltage source which is parallel to the roll and a short distance away from it. As the raw ore dropped on the roll goes through the corona discharge, the more nonconductive material is repelled and dropped into the bins containing the gangue. The iron ore which is more conductive is not repelled and drops on to a conveyor or into the product bins. Voltages of 40,000 to 50,000 are used and the rotational speed of the drum is varied to effect various kinds of separation. The process is flexible and production cycle may incorporate recycling of middlings to suit various ore supplies and finished product requirements.

The process can easily take ores with iron content as low as 26 per cent and beneficiate these up to better than 68 per cent iron. It is believed that the process may, in some instances, give such good recovery of ore from secondary deposits that a concern may get better ore from beneficiating the lower grades than from high grade direct shipping ores. Sometimes it may be necessary to heat the ore sufficiently to dry off the surface water which may affect conductivity. It is claimed that the process can be operated at separation costs in the order of 4¢ a ton. Although high voltages are used, the current is small in the range of 20 milliamperes. Current requirements are estimated at about one kwhr per 100 tons of product for the high voltage portion of the equipment. Current needed to operate the rolls and so forth is, however, greater than this. Single simple units can handle up to 100 tons an hour and an actual installation would involve the use of various combinations or batteries of units. Capital costs are relatively low and it is estimated that a high tension separator installation with product capacity of 200 tons an hour would be in the order of several million dollars.

The final product is a powder which may require agglomeration for blast furnace use but which possibly could be used directly in some of the direct reduction processes such as the H-iron process.

A Carpco pilot plant is being furnished by Joy to the Jones & Laughlin Steel Corp. for use in the ore research laboratory at Negaunee, Mich. ▲

Figure 1 — Carpco high tension separator will be manufactured and sold to the iron ore industry by Joy Manufacturing Co.



by Alonzo F. Kenyon,
Advisory Engineer,

Industrial Engineering Dept.,
Westinghouse Electric Corp.,
East Pittsburgh, Pa.

Figure 1 — Operating side of 48-in. wide two-stand temper pass strip mill shows operator's cabinets. The mill has a 3000 to 5000-fpm operating speed range. The main drives for the two mill stands, entry and delivery tension rolls, and unwinding and winding reels, total 4600 hp.

Temper Pass Mill Provides Large Power and High Speed

A NEW 48-in. two-stand strip mill was recently put into service at the Wheeling Steel's Yorkville, Ohio, plant. The mill is intended primarily for temper pass rolling of annealed cold reduced tinplate strip. It also may process some intermediate gage strip.

Motors totaling 4600 hp drive the two mill stands, the entry and delivery tension rolls, and the unwinding and winding reels. The motor drives are selected to provide 3000/5000 fpm operating speed with the expected mill and tension roll diameters.

Table I gives full data on the drive units employed in the installation.

On No. 1 stand only the bottom backing roll is driven. On the No. 2 mill stand, and the entry and delivery tension roll stands, twin-motors are provided for separate drive of the top and bottom rolls.

The reel mandrels are 20½ in. diam, and can handle coils up to 72 in. maximum O.D., 45,000 lb maximum weight.

All the drives mentioned are operated in a separate generator adjustable voltage system. The strip tensions developed by the reels and tension rolls are controlled by 400-cycle magnetic amplifier regulators. The tension between No. 1 and No. 2 mill stands is controlled by a regulating tensiometer, operating through a magnetic amplifier, to adjust the No. 1 stand speed. The No. 2 stand is the reference stand to which the other drives are matched.

All the main and auxiliary drive equipment, ventilation equipment, switchgear and auxiliary power and lighting power center substations were supp ied by Westinghouse Electric Corp. ▲

TABLE I
Main Drive Unit Data

Application	Machine type	Rating			Comments
		Output	Voltage	Speed, rpm	
Entry unwinding reel	Drag generator	450 kw	550	250/950	Direct coupled to an expanding mandrel reel
Entry tension rolls	Single-armature drag generator	100 kw	250	500/1000	Used on bottom roll
	Double-armature drag generator	200 kw	250	500/1000	Used on top roll
					Special small-frame machines assembled on 21-in. vertical centers for direct coupling to the tension rolls
No. 1 mill stand	Synchronous motor	750 hp	600	205/410	Direct-coupled to the bottom backing roll Roll diameter may vary between 46 and 56 in.
No. 2 mill stand	Two synchronous motors	750 hp each	600	500/1000	Connected to the mill working rolls through one-to-one off setting gears Roll diameter may vary between 18½ and 23 in.
Delivery tension rolls	Single-armature motor	250 hp	250	525/925	Used on bottom roll
	Double-armature motor	500 hp	250	525/925	Used on top roll
					Special small-frame motors assembled on 21-in. vertical centers for direct coupling to the tension rolls
Tension winding reel	Synchronous motor	600 hp	600	250/950	Direct-coupled to the reel

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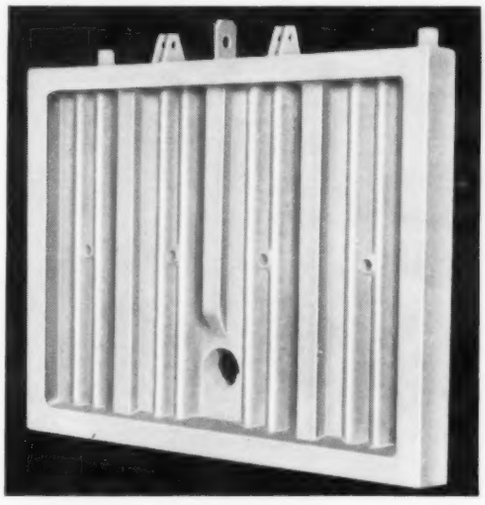
Sticker equipment has proven itself in Steel Plants throughout this continent Safety, economy, and performance are built into every product under our exclusive *unconditional guarantee of performance and quality.*



"STUDLESS" OPEN HEARTH FURNACE DOOR
(Patented.)

← Corrugations provide structural strength and all-directional radiation for longest lining life. Self-retention for plastic linings with no studding. EXCLUSIVE.

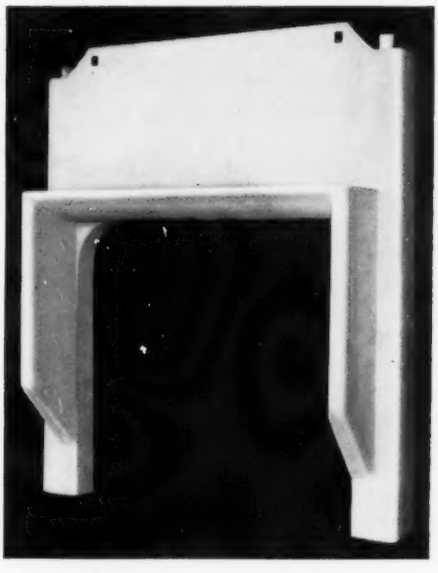
Another Sticker Exclusive →

VIBRATORY LADLE FEEDERS AND CONVEYORS
(Patents Pending.)

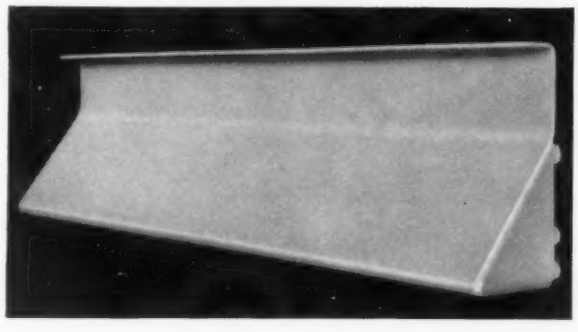
With or without facilities for on-the-spot weighing of maximum ladle additions, with controlled flow rate, fitting any space limitations. Minimum human error, fade-out, and loss of fines result in maximum alloy yield for unbelievably fast investment return.

WATER-COOLED CHARGING DOOR FRAMES WITH JAM GUARDS →

Simplest or most complex types. Sticker frames excel in performance. Design shown here penetrates masonry front wall 13½" to absorb charging impact.



OPEN HEARTH FURNACE SEAMLESS-FACE SKEWBACK CHANNEL



(Patent Pending.)
← Sticker's contribution to this failure-proof water-cooled channel, with self-contained skew tile, is its one-piece furnace side. EXCLUSIVE.

Two Other Sticker Exclusives . . .

LADLE MAINTENANCE "SAFETY CAGE" ***(Patented.)***
For safe and comfortable nozzle and stopper rod setting in hot ladles, immediately after pouring steel.

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Strong steel centers to replace unsafe and costly wood, reducing open hearth rebuild time by at least eight hours. Unequalled safety.

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Orville L. Welsh ASST. CHIEF ENGINEER, CONTINENTAL BAKING CO.

"Experience proved to us, Fusetron Fuses could save us money and provide safer protection." . . . *Orville L. Welsh*

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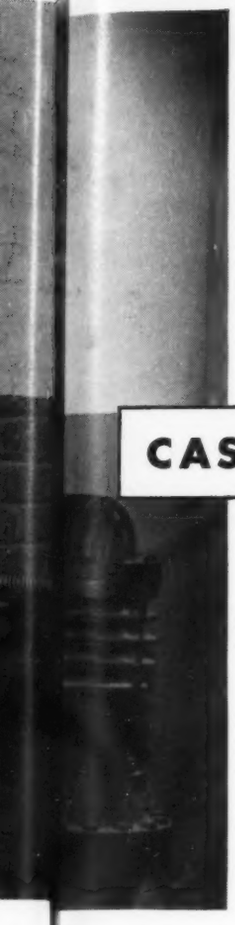

CASE 1

"A refrigeration compressor of ours was frequently being shutdown because the 60 amp. protection we used just could not hold the starting currents.

"After reading over Fusetron dual-element fuse literature sent to us by our company headquarters, we tried them out with great success. In the past twelve months, we have not had to go near the switch or open its cover.

CASE 2

"In another case, Fusetron fuses saved us a considerable amount of money. We installed 600 ampere Fusetron fuses in parallel in our 1200 ampere entrance switch, rather than using the more expensive mechanical type of protective device.

"Personally, I am confident we now have better protection than we could have had with other types of protective devices."

Here's why FUSETRON dual-element fuses provide safer, more dependable and money-saving protection . . . FUSETRON dual-element fuses provide 10 point protection against electrical troubles. This is unlike circuit breakers or ordinary fuses which, except in rare cases, protect only against short-circuits.

IN ADDITION:

Fusetron fuses require no maintenance or recalibration. They are calibrated at the factory by engineers. Once properly installed, they require no inspection or down-time necessary on mechanically operated devices. There are no hinges, pivots or contacts to stick or get out of order. Dust, corrosion or oxidation cannot increase a Fusetron fuse's capacity or lengthen its blowing time.

After years of inactivity, a Fusetron fuse will give the same safe, dependable protection if called upon to open as it would have on the day it was installed.

Fusetron fuses have high interrupting capacity. FUSETRON fuses can safely interrupt severe short-circuit currents and are adequately safe to meet future circuit growth.

Fusetron fuses save on installation costs. Because their long time-lag prevents them from opening needlessly on motor starting currents or other harmless overloads, Fusetron fuses can be installed in sizes to approximate the load current. This protects against waste of space and money by permitting use of proper size switches and panels.

Why Risk Losses! One needless shutdown . . . one lost motor . . . one destroyed switch or panel . . . one burned out solenoid . . . may cost you far more than replacing all other types of protective devices throughout the entire installation with Fusetron dual-element fuses.

For Loads above 600 and up to 5,000 amps . . . Use BUSS Hi-Cap Fuses. They have an interrupting capacity sufficient to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuit of origin.

for more information write for { BULLETIN FIS on Fusetron fuses. / BULLETIN HCS on BUSS Hi-Cap fuses.

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TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
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for safe, modern money-saving protection install FUSETRON dual-element FUSES and BUSS Hi-Cap FUSES throughout entire Electrical System!

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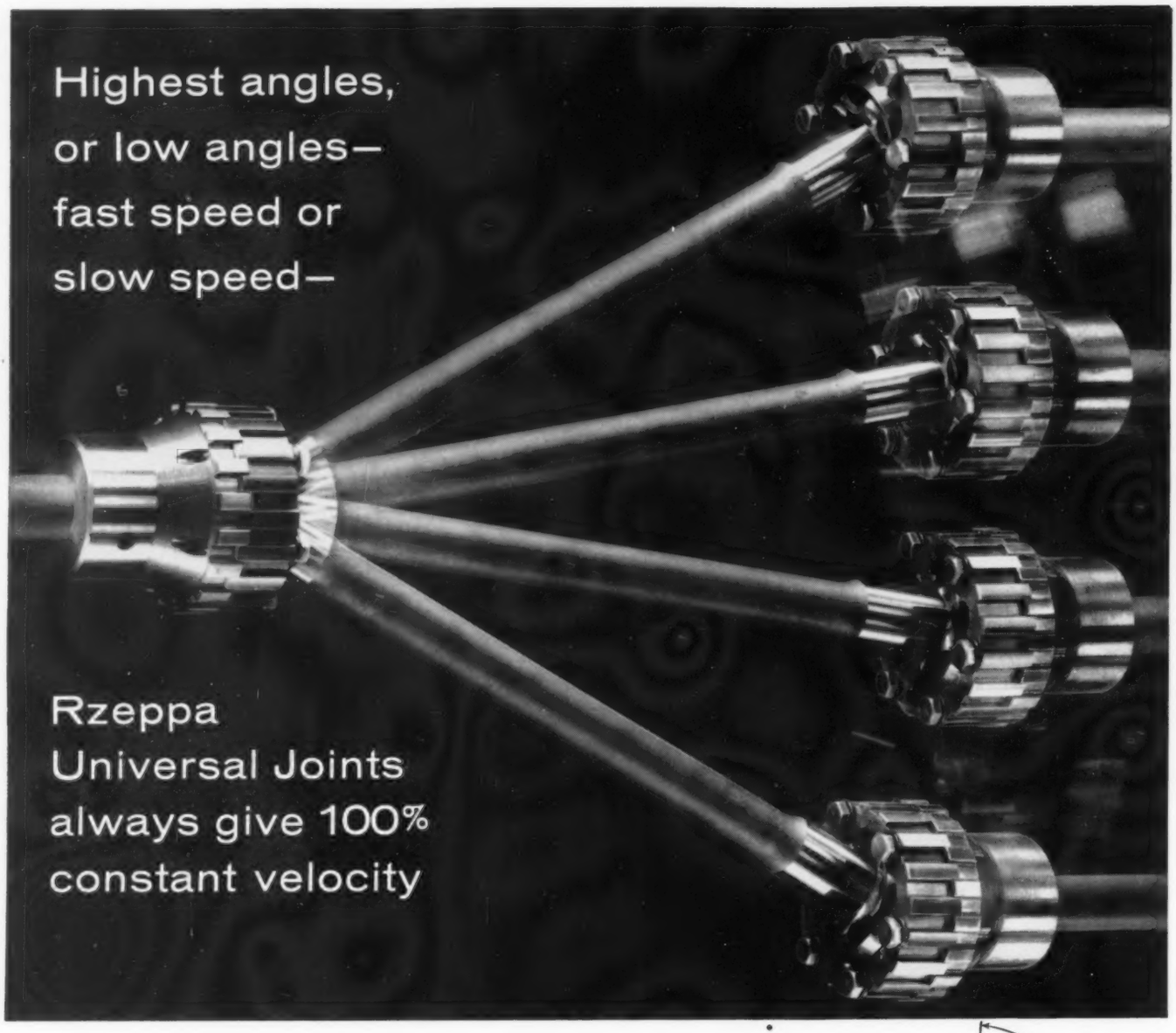
BUSSMANN MFG. DIVISION, *McGraw-Edison Company* **University at Jefferson, St. Louis 7, Mo.**



No matter what the application—aircraft, marine, vehicular or industrial, Rzeppa (pronounced "Sheppa") Constant Velocity Universal Joints operate without chatter or bounce, assure longer joint and shaft life through ball-bearing smoothness.

Combining Constant Velocity with higher usable working angles, Rzeppa Joints have the strength and capacity for heavy-duty coupling and drive-line jobs, yet their inbuilt precision provides vibration-free performance in the most critical design applications.

SEND TODAY for complete performance and engineering facts on the complete line of Rzeppa Constant Velocity Universal Joints.

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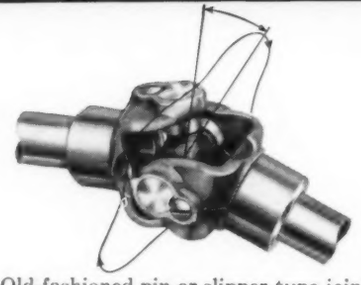
50th ANNIVERSARY—1908-1958

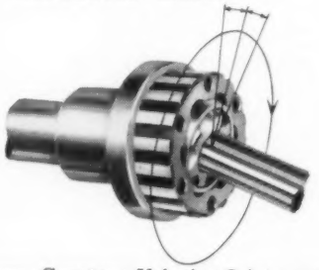
Constant Velocity Universal Joints

58RJ—3

THE GEAR GRINDING MACHINE CO., 3929 CHRISTOPHER, DETROIT 11, MICHIGAN • MANUFACTURERS OF FULLY AUTOMATIC GEAR GRINDING MACHINES



Old-fashioned pin or slipper-type joints speed up and slow down twice during one revolution, must use precision alignment techniques to compensate for "rock and roll" action.



Rzeppa Constant Velocity Joints operate smoothly. Reduced friction insures trouble-free service, low maintenance costs.

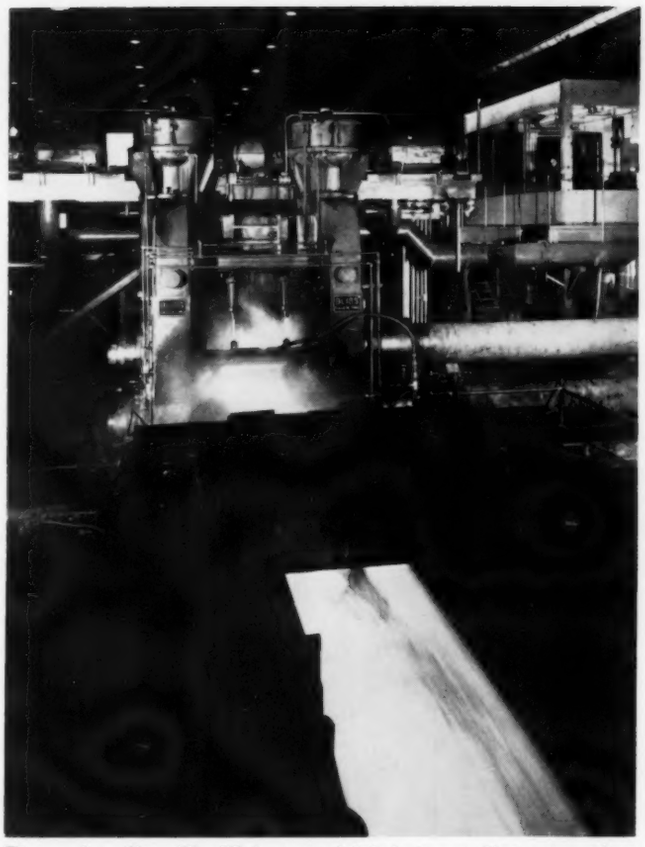


Figure 1 — New 38 x 52-in. two-high intermediate reversing roughing mill recently replaced three-high one-way mill in Empire Steel's 48-in. hot strip line at Mansfield, Ohio.

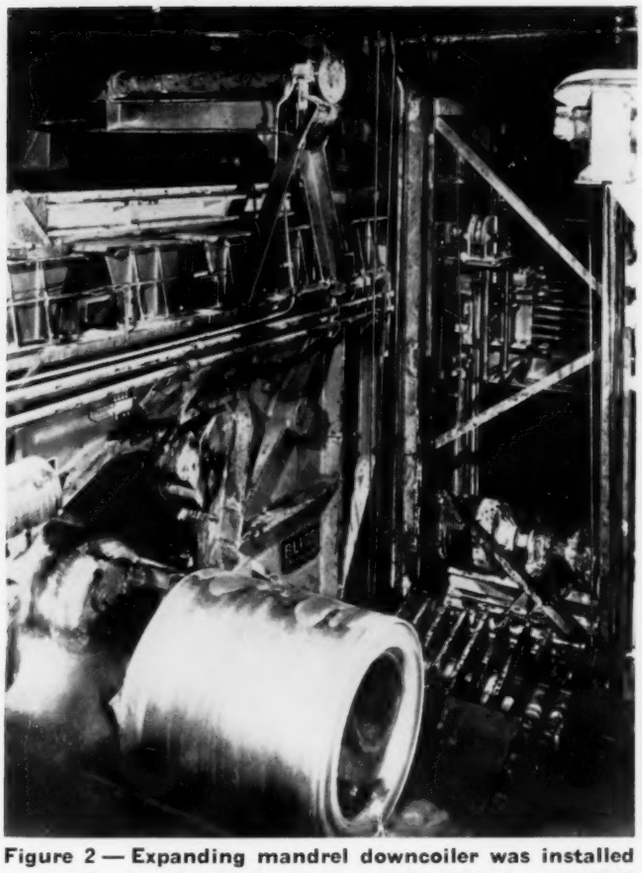


Figure 2 — Expanding mandrel downcoiler was installed to handle the increased output provided by the modified strip line.

Modifications Double Capacity of Empire-Reeves Hot Strip Mill Line

AS it becomes harder and harder to show a profit in the face of scanty orders and rising production costs, steel plants are taking a new look at old production facilities to find hidden bottlenecks that hold down production efficiency.

Even the continuous strip mill—long regarded as a model of efficiency—is coming in for its share of attention, especially where roughing passes are performed by a reversing cycle rather than on a straight-through basis.

Such a new look at an existing mill was taken at Empire Steel Corp. now Empire-Reeves Division of Universal-Cyclops Steel Corp. While its existing mill was capable of producing high quality, fine gage strip in a straight line without reheat, Empire-Reeves felt that it was not getting the production it could.

Six years ago this hot strip line had received wide attention when it was modernized by E. W. Bliss Co.'s rolling mill division. So officials once more called in the Bliss Rolling Mill Division to do the job of revamping the rolling cycle without affecting the rolling arrangement.

The result was continued high quality at double the mill output. With the addition of three units—an intermediate roughing stand, a flying shear and a downcoiler—the capacity of the line went from 15 to 30 ingots an hour. Also Empire-Reeves continued to produce fine gage strip in straight line operation without reheat.

Before the new modifications were installed, this was how the line was set up: a reversing slabbing-blooming mill, followed by edging rolls and a crop shear, an intermediate one-pass roughing stand, a four-stand tandem finishing train of 4-

New Wheelabrator® Ultra-Filtration keeps control room air "vacuum" pure

Wherever ultra-clean air is essential, as in this electrical equipment control room of a leading steel mill, low-cost Wheelabrator **Ultra-Filtration** provides the most effective and economical method you can employ.

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Control and motor rooms, laboratories, instrument and spectograph areas — or areas that must have dependably and consistently pure air — are best protected by Wheelabrator Dustube Ultra-Filtration. Machinery and instruments function more consistently with minimum downtime and maintenance caused by air-borne contaminating particles. And the Ultra-Filtration unit itself works continuously and automatically, with no attention and practically no maintenance cost.

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high mills, runout table and upcoiler.

Ingots rolled ranged in weight between four and five tons, with an average rate of production of 15 ingots per hour.

The rolling cycle included 17 to 21 passes through the slabbing mill to reduce the 18-in. ingot to approximately $\frac{7}{8}$ in. thickness. After end cropping, the slab was passed through a one-way intermediate rougher, reducing it to half-inch thickness in a single, heavy pass. It then moved on to the finishing train, emerging from No. 4 stand in finished thicknesses as fine as 0.080 in.

The new changes in the line permit a cycle which greatly reduces the load on the slabbing mill. Here is how the rolling cycle operates now:

1. Ingots are reduced from 18- to 5-in. thickness in 11 to 13 passes through the slabbing mill.
2. Ends are cropped in a crop shear.
3. Seven passes through the new Bliss intermediate roughing mill reduce the slab from 5 to 0.50 in.
4. Ends are cropped in the new upcut, or flying shear installed before No. 1 stand of the finishing train to eliminate "fishtailed" ends.
5. Strip is passed through the finishing train to the runout table and on to the new Bliss downcoiler, which was installed to handle the increased output of the modified line.

As a result of this new cycle, ingots processed per hour have jumped from 15 to 30, mostly because the new intermediate roughing mill greatly cuts the time each ingot spends in the slabbing mill.

Important to the speed of the intermediate rougher is its automated control system, where Westinghouse-Prodac and IBM-Recordak controls are set by means of punch cards made up in advance for each specific grade and gage of steel rolled. The operator inserts the proper card into the console at the start of each heat. Then, as the slab approaches from the crop shear following the slabbing mill, he pushes a button for the first pass. Rolls and mill speed are set automatically by the card control system. Another push of the button, and the mill is set for the second pass, and so on until the whole seven-pass cycle is completed. ▲

New Oxygen Plant Starts Operation At U. S. Steel's Gary Plant

A NEW oxygen-producing plant recently began operation at United States Steel Corp.'s Gary Works. Built, maintained and operated by Linde Co. Division of Union Carbide Corp., the unit will produce 94,000,000 cu ft a month of high purity oxygen for Gary Works and Gary Sheet and Tin Mill demands. The oxygen will be used for cutting, scarfing, scrap preparation and for increasingly important metallurgical processes.

This new oxygen plant represents one phase in U. S. Steel's continuing program of modernization and improvement. It also marks another link in the growing chain of industry's recognition of the role of the "specialist." For, although the oxygen-producing plant is located on steel company property, Linde is responsible for its erection, operation and maintenance, as an extension of its oxygen supply methods.

Although a Linde plant superintendent will make regular inspections, and will oversee maintenance operations, the new oxygen plant is designed for automatic, unattended operation. Through a unique control system, the plant will automatically produce oxygen at the rate required by the mill's operations, pump oxygen into storage tanks for standby and "peak" requirements, and regulate the operation of a host of valves, meters, motors, switches, etc. An electronic monitoring system, reporting continuously to a central office, keeps track of the operation of important components to aid in the advance detection of possible trouble. If the monitoring system gets a warning of trouble ahead, one of several Linde supervisors is notified immediately so that the condition can be corrected without a curtailment of operations.

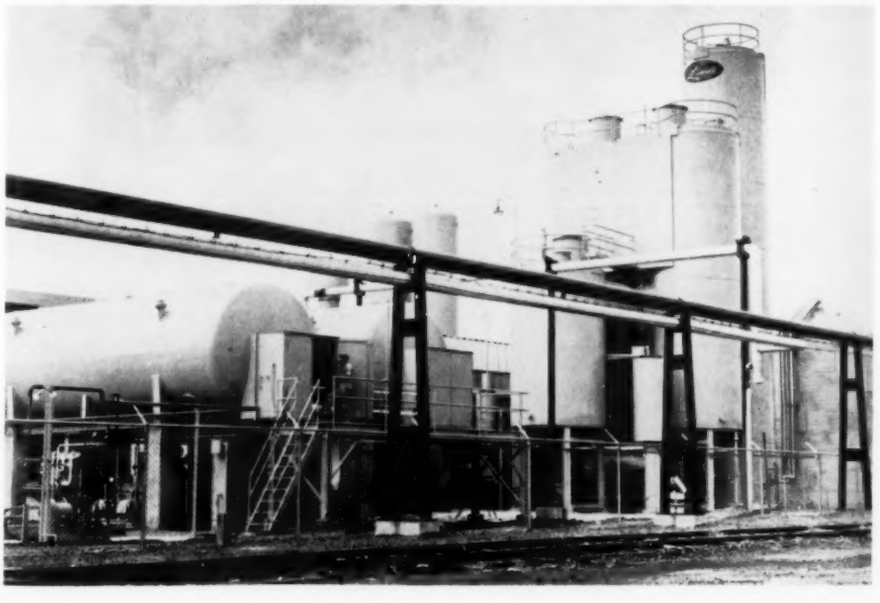
In addition to supplying oxygen produced by the on-site plant, Linde will provide uninterrupted service during scheduled or non-scheduled plant shutdowns by meeting mill requirements with Driox liquid oxygen from regular production and distribution facilities. Back up oxygen needs will be satisfied by the unit's liquid oxygen standby storage tank which automatically begins operating if the oxygen plant is down for any reason. This oxygen reserve is replenished by tank car or truck shipments of liquid from Linde's large plant at East Chicago.

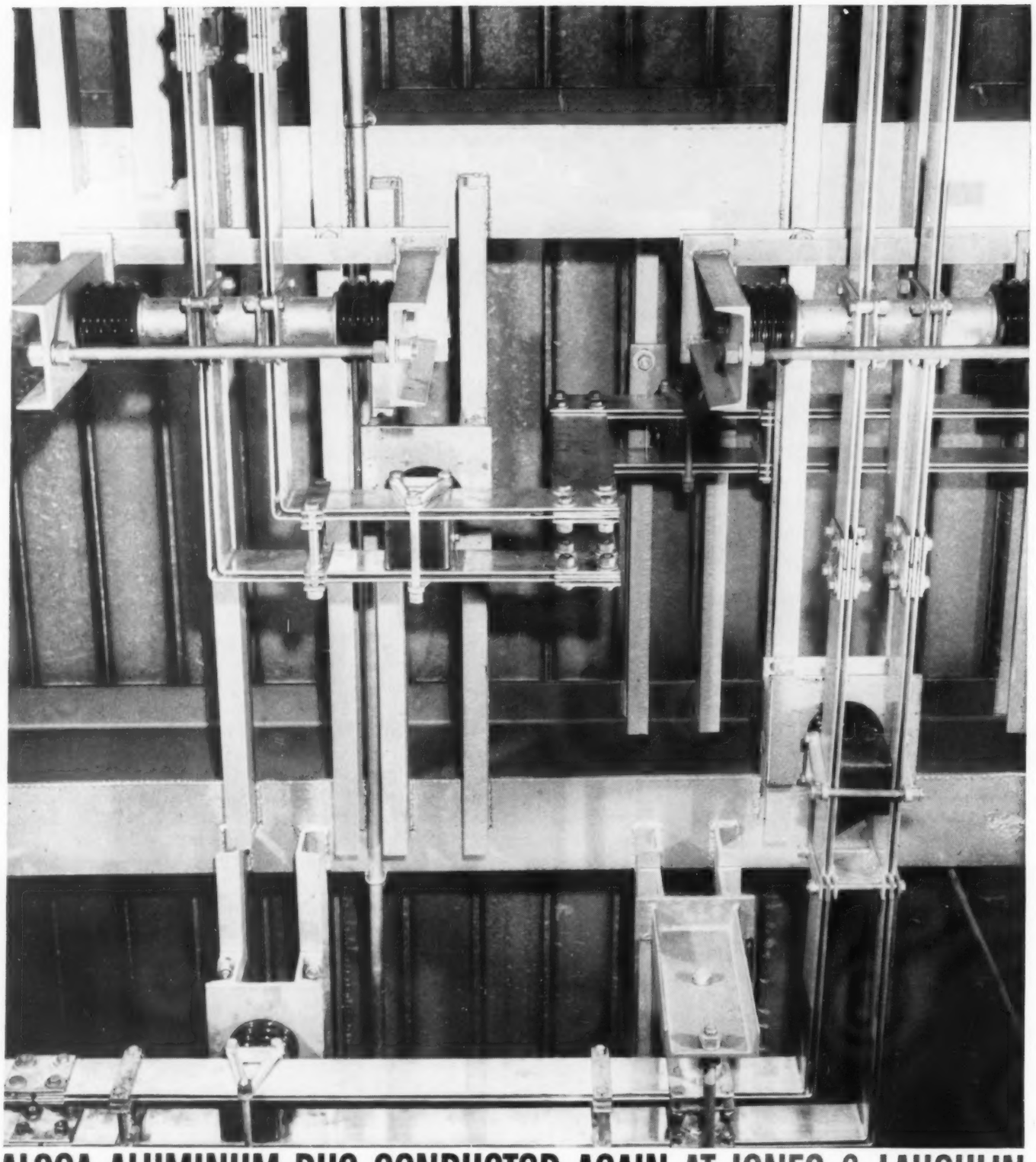
The plant draws in atmospheric air which is filtered, compressed and cooled and introduced into an interchanger where it undergoes further cooling, removal of impurities and other atmospheric gases until the resultant oxygen produced is a minimum of 99.5 per cent pure. This high purity oxygen is either stored or piped to a point for immediate use in steelmaking.

The Driox oxygen standby storage facility stores oxygen in its liquid state. The temperature of this liquid oxygen is −297 F. This facilitates storage and conserves space since the volume ratio of gaseous to liquid oxygen is 862 to one. Liquid oxygen can be immediately converted to gaseous oxygen as it is needed.

This unit marks the latest of a series of installations which demonstrates Linde's faith in the future of the steel industry and U. S. Steel's confidence in the increased use of oxygen in steelmaking. The use of oxygen in steel production has soared from about 30 cu ft per ton in 1930 to today's national average of about 200 cu ft per ton. To help meet this growing need, Linde on-site plants recently went "on-stream" at U. S. Steel's Duquesne, Homestead, Edgar Thomson Works and South Works in Chicago, as well as on the property of several other industrial installations. Linde has also undertaken a program of expansion at its mass producing plants, such as those at East Chicago and Ashtabula. ▲

Figure 1 — New oxygen plant at U. S. Steel's Gary works is rated 135 tons a day.





ALCOA ALUMINUM BUS CONDUCTOR AGAIN AT JONES & LAUGHLIN

Jones & Laughlin Steel Corporation *again* used Alcoa® Aluminum Bus Conductor in their Aliquippa, Pa., Hot Strip Mill and saved almost 50 per cent over a comparable copper installation.

The 21-year record in a hot strip mill at their Pittsburgh Works had already proved the satisfactory performance of Alcoa Aluminum Bus Conductor.

Low material cost, low installation and maintenance costs plus easy-to-make, low-resistance connections are strong reasons to use Alcoa Aluminum Bus Conductors in the steel industry. Immediate delivery of rectangular bus conductor in popular sizes is available from your Alcoa Distributor. Call him before completing plans for plant modernization or expansion. Or write, Aluminum Company of America, 2310-K Alcoa Building, Pittsburgh 19, Pa.

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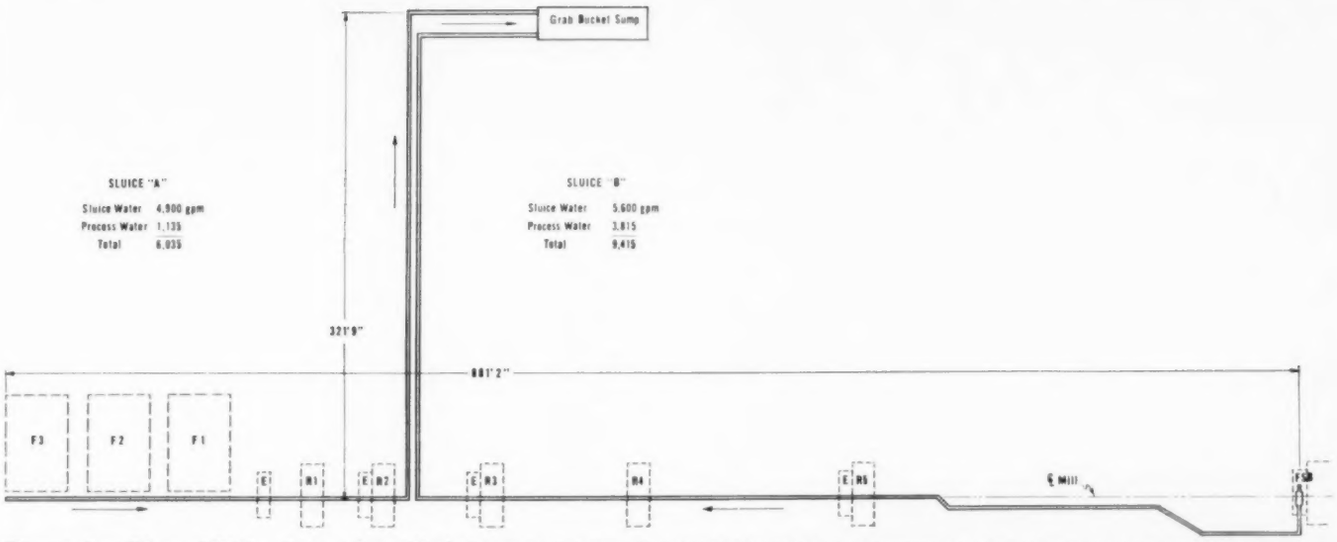

Figure 1 — Plan of 54-in. hot strip mill sluiceway system. At the right of the diagram is the start of the finishing mills, not served by this sluiceway.

MODERN SLUICEWAY DESIGN Removes Mill Scale

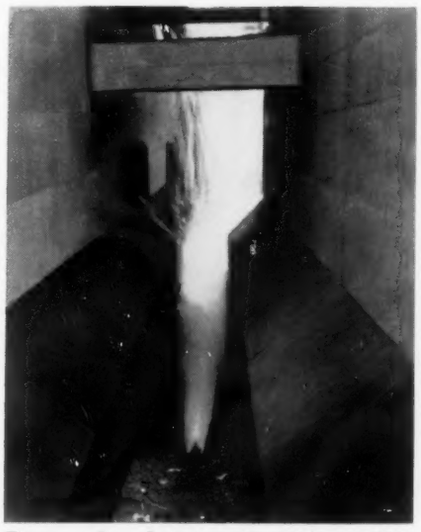

Figure 2 — Origin of sluice "A." What appears to be water falling from above is actually white hot pieces of scale. Quantity of scale collected is greatest here and at the first vertical edger.

Figure 3 — Typical nozzle location. Note the overhang of the upstream liner.

DURING August, 1955, what is probably the world's largest and most modern sluicing system for removing scale from a hot strip rolling mill was placed in operation at National Steel Corp.'s Weirton steel division. The contractor was Dravo Corp., Pittsburgh, Pa., representing the Allen-Sherman-Hoff Co., Wynnewood, Pa.

The scale handling system consists of two separate sluiceways extending from the various points of collection to a concrete scale sump. Unlike the conventional scale removal system which operates with low-velocity—large volume water, this system employs relatively low volumes of water at high pressures. This, "pushing with high pressure water," method offers many advantages in operation and main-

tenance, and has an important advantage in considerably lower original capital investment. The more conventional "flooding" method requires deep sumps at each descaling location—often 40 ft or more below the floor level. In contrast, the difference in elevation between the point of origin of sluice "A" and the single scale sump 680 ft away is only 6 ft-1⅛ in. The savings in construction and installation costs are considerable.

The sluiceway is a horizontal concrete trench with the sides and bottom protected against wear by a series of half-round, cast nickel-iron liners, placed end to end. These liners are arranged on a slight upward slant in a "sawtooth" design, so that in effect the sluicing is uphill. The actual flow line (bottom of the metal liners) varies slightly, from 2½ to 5½ in. slope per hundred ft, depending upon conditions. There are a total of 659 liners in the system; 539 are 24 in. wide, 120 are 18 in. wide.

Figures 4 & 5 — These views of the same section of the sluiceway were taken about three minutes apart, and illustrate the "raging torrent" of water that is produced by the jets.

Sluice "A," the shorter of the two sluiceways, serves the reheat furnaces, two vertical edgers and two roughing mills. Sluice "B" serves two vertical edgers, three roughing mills and the finishing scale-breaker. Both sluiceways discharge into the common concrete sump; from this sump about 172 tons of mill scale are removed each working day.

Sluiceway "A" carries the greater quantity and the larger pieces of mill scale. It originates at the end of the reheat furnaces and extends 273 ft, under a 42-in. vertical edger, a 44- x 54-in. two-high roughing mill, a 33-in. vertical edger and another 44- x 54-in. roughing mill.

Downstream a little past roughing mill No. 2, sluice "A" makes a 90-degree left turn for 322 ft, then another 90-degree turn, right, for another 85 ft. At this point the sluice discharges against a splash plate, the water and scale dropping about 10 ft into the scale sump.

There are 33 nozzle locations along the length of sluice "A." The number of nozzles at each location and the placement of these stations is determined by the amount of mill scale and process water being handled. Design data for this sluice called for 1135 gpm of process water. (Process water, in this instance, is all the water entering the system other than through the sluice nozzles; it consists primarily of descaling water and cooling water for the roughing mill rolls.) There is no question that the quantity of process water being handled is far in excess of the original design data.

At startup, sluice water was 220 psi at the nozzles. It has been possible to reduce this pressure to the present 165 psi, and the engineers who developed the system believe further reductions are possible and probable.

Sluice "B," because it is almost 50 per cent longer than "A," carries more total water than does sluice "A." It originates at the other end of the rolling table, under the finishing scale breaker, as an 18-in. sluiceway. Before passing under No. 5 mill, it is stepped up to 24 in., the same as sluice "A." Sluice "B" passes under a 35- x 49- x 54-in. four-high roughing mill (No. 5), a 24-in. vertical edger, another four-high roughing mill (No. 4), a 44- x 54-in. two-high roughing mill (No. 3), and a 24-in. vertical edger. At this point, roughly 593 ft from the point of origin, sluice "B" makes a 90-degree right turn, paralleling sluice "A," and follows "A" to the point of discharge into the scale sump.

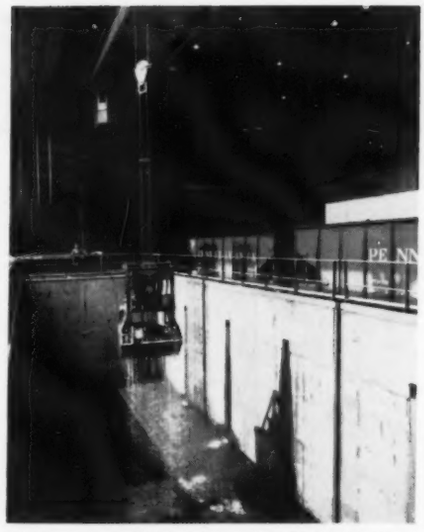

Figure 6 — Scale is collected and removed daily from this grab bucket sump and loaded into the rail cars at the right. About three carloads of scale are removed each working day.

Only 27 nozzle locations are required to serve sluice "B," the lesser quantity reflecting the smaller amount of scale being collected and transported by this sluice. Design data called for 3815 gpm of process water for sluice "B," but, like "A," this is also transporting a much greater volume.

In all other respects the two sluiceways are similar.

The concrete scale sump is located at the east edge of the plant, about 315 ft from the center of the mill table. This sump is 20 ft-8 in. wide, 75 ft-6 in. long and 39 ft deep. Two underflow baffles force the deposit of scale particles in the front two-thirds of the sump. The clear water overflows to discharge.

Scale is removed daily from the sump by clam-shell bucket, and loaded into railcars parked on an adjacent siding. Careful records of the quantity of scale removed have been kept; latest figures indicate the scale is running about two per cent of mill capacity, or about 172 tons per day. About 95 per cent of this is used by the company's four blast furnaces. ▲

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Air intakes and outlets are positioned to provide complete dripproof protection.

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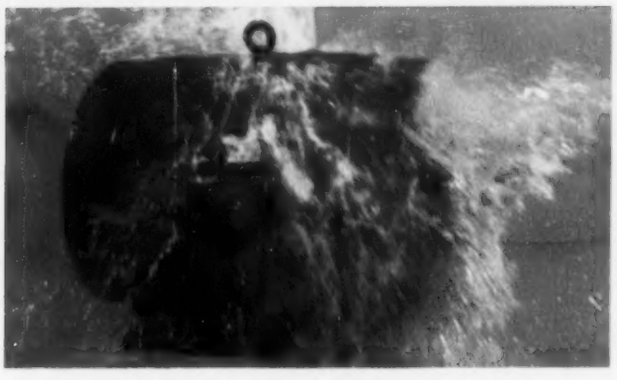
1 to 125 hp



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Wagner Type DP Motors offer the *double protection* of rugged corrosion-resistant cast iron frames and dripproof enclosures so well designed that the DP Motor can handle many applications that formerly required splashproof motors.

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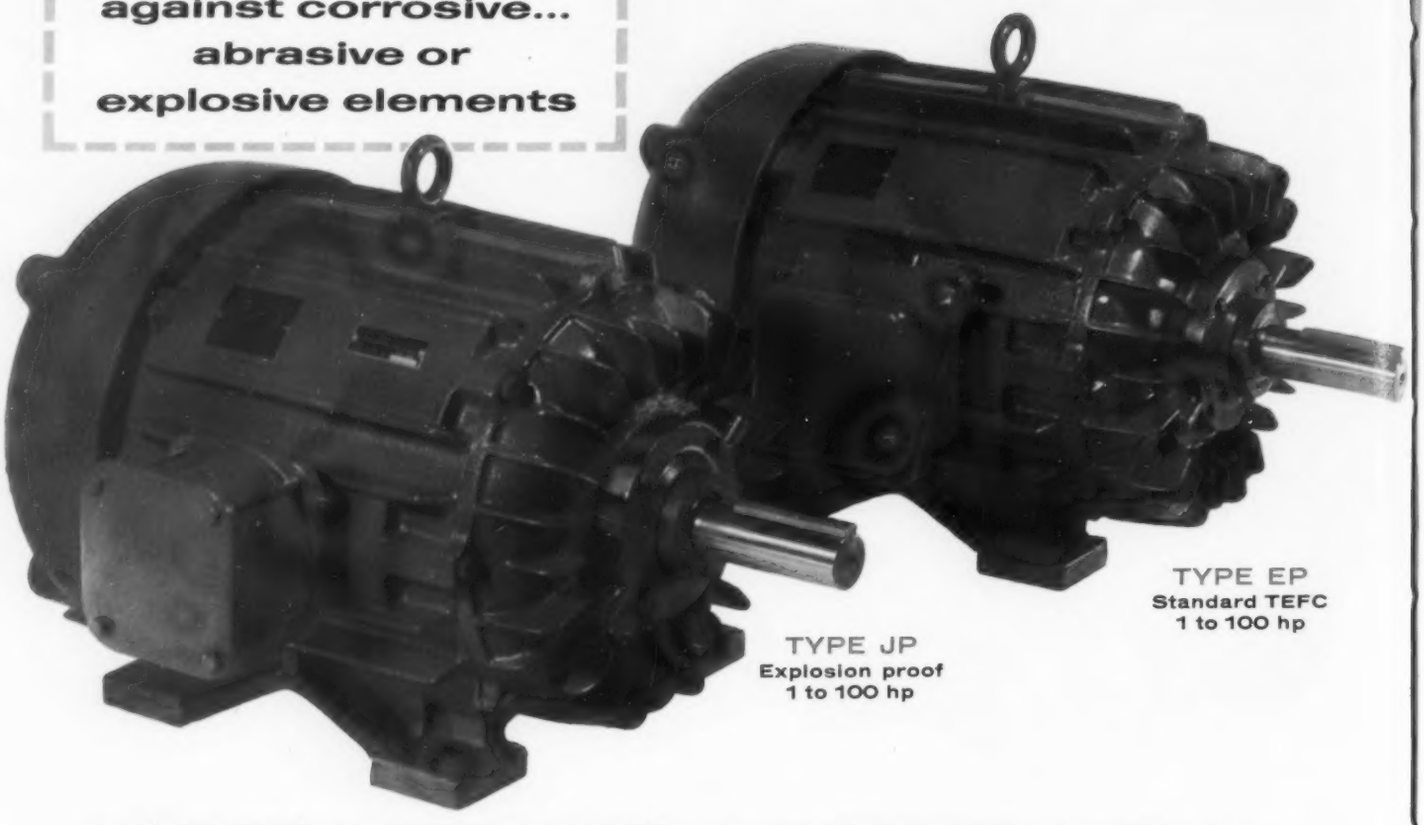

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TYPE JP
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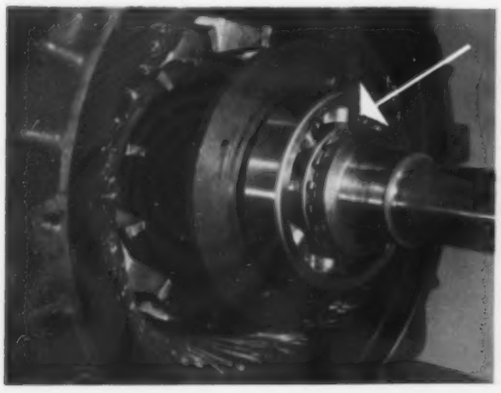
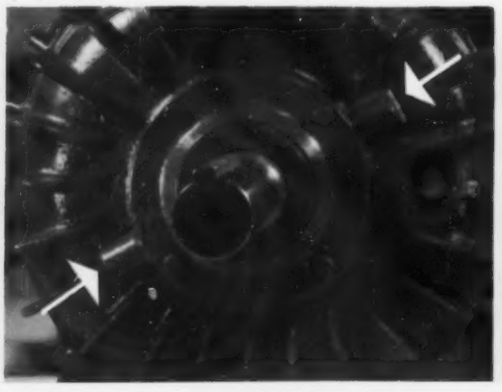


BEARINGS CAN BE RELUBRICATED

Factory lubrication will last for many years under normal service, but openings are provided to permit relubrication that adds years to motor life under severe conditions.



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Both ends of these motors have running shaft seals to keep the bearings clean. Bearing housings are effectively sealed to prevent escape of grease.

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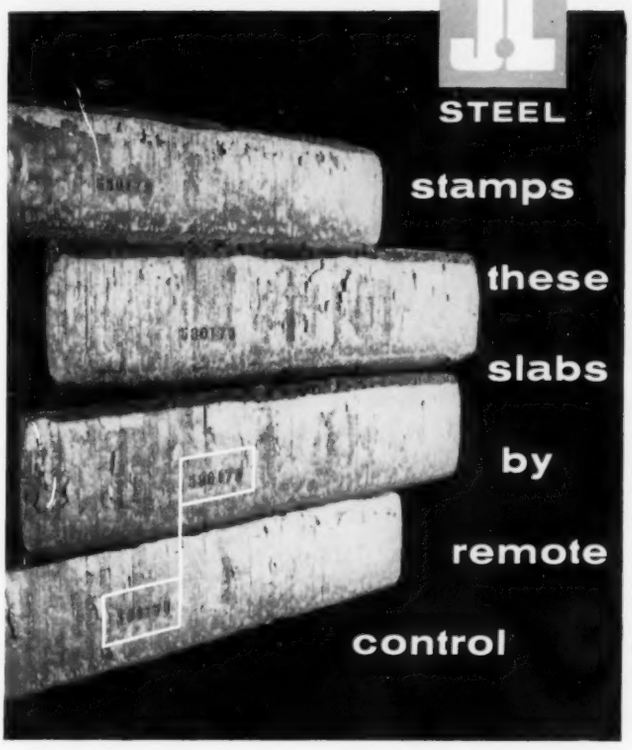
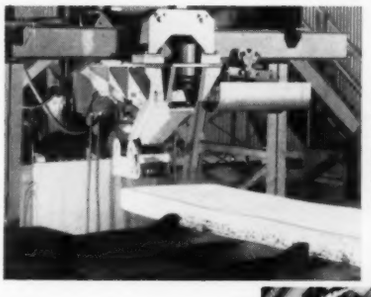
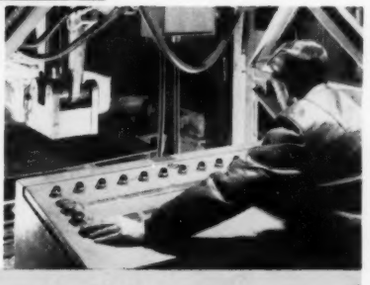


Deep, clear-cut, even impressions in slabs and blooms—*it's being done by remote control* at the 44" Blooming Mill in Jones & Laughlin's Aliquippa Works. This machine does the job better, faster, more economically, more safely than hand methods previously used. *Write for new bulletin on Remote-Control Marking.*



Slab in position for stamping with pneumatically-powered marking head. Both blooms and slabs are marked by the machine at J & L.



Any of the nine numbers in the marking head may be changed by pressing buttons on this control panel. A single button also actuates the stamping cycle.

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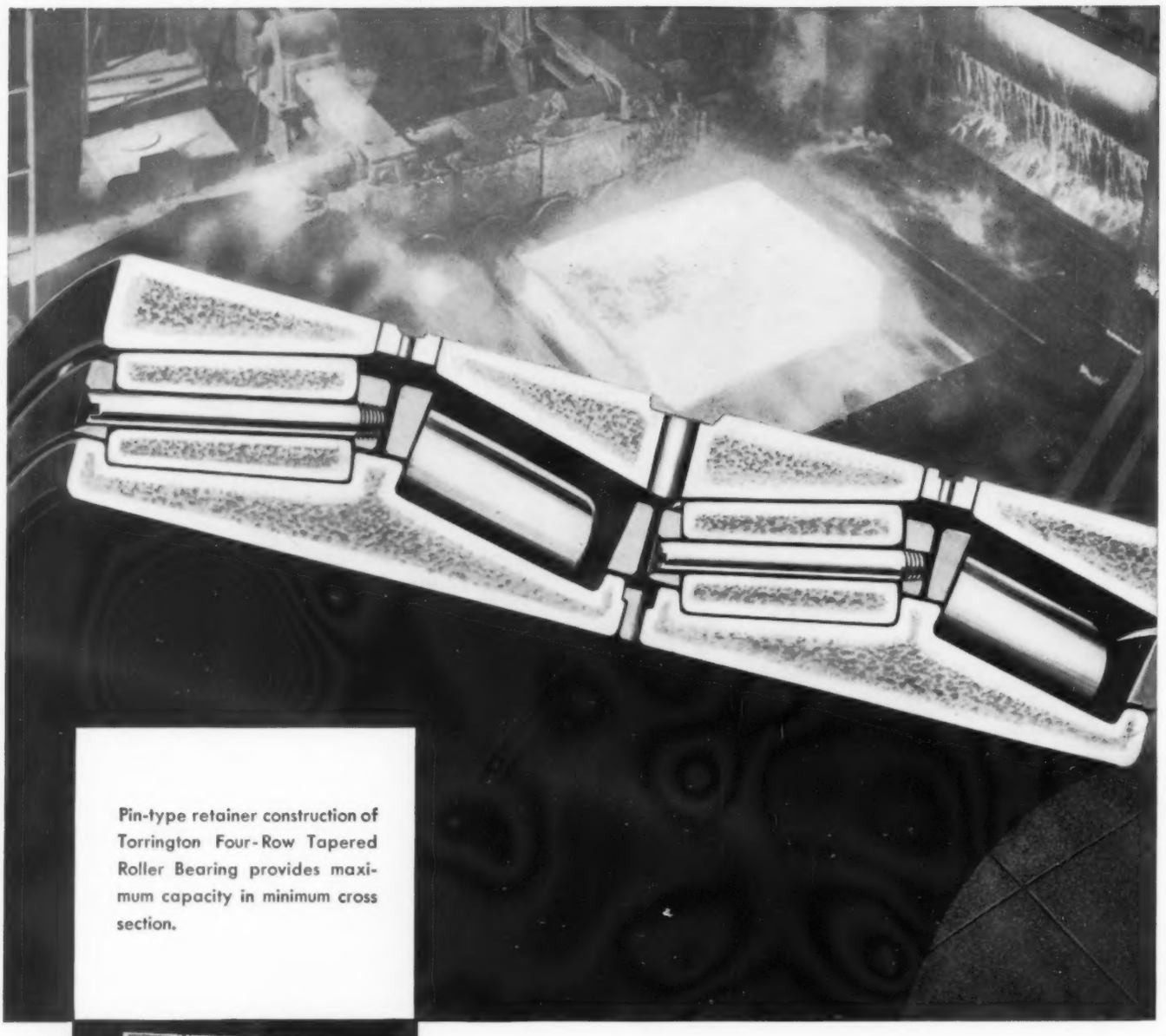
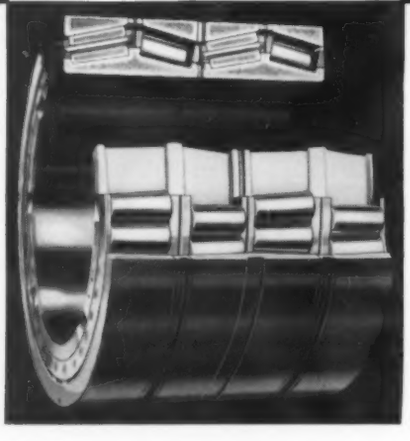


Pin-type retainer construction of Torrington Four-Row Tapered Roller Bearing provides maximum capacity in minimum cross section.



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In design, selection of materials and precision construction, Torrington spares no detail to insure maximum bearing capacity and life expectancy in roll neck bearings.

For example, where rolling mill window openings and roll diameters limit roll and bearing dimensions, Torrington design provides for minimum bearing cross section and maximum roll neck diameters. Rollers are longer and pin-guided to allow closer spacing and greater area of contact surface, providing a much greater load capacity.

Care in such details, and in proper selection of the *right* bearing for your application, pays off in tonnage rolled. For most satisfactory performance, make Torrington Bearings your selection. **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

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Date-line Diary...

September 1

△ The AISI reports that the operating rate of the steel industry for the week of September 1 is scheduled at 1,707,000 tons (63.2 per cent of capacity). This compares with 1,715,000 tons one week ago (63.5 per cent capacity) and 2,073,000 tons one year ago. Index of production for the week is 106.3.

September 3

△ The Federal Reserve reported that consumer installment debt, seasonally adjusted, fell to $33,100,000,000 in July, down $32,000,000, but still $165,000,000 above the year earlier figure.

△ The Bureau of Mines, Dept. of the Interior reported that iron ore produced in the United States in 1957 amounted to 106,148,419 long tons, compared with 97,849,650 in 1956; shipments in 1957 were 104,969,871 long tons valued at $874,884,972 or $8.33 per ton at mine, compared with 97,896,719 tons, $757,039,618 and $7.73 for 1956; consumption in 1957 totaled 129,375,234 long tons compared with 125,170,702 in 1956.

September 4

△ Commerce and Labor Depts. reported that construction during August rose seasonally to $4,800,000,000, $160,000,000 above July, 1958 and $136,000,000 over August, 1957.

△ Westinghouse Electric Corp. reports it has developed ceramic materials which can convert heat directly into electricity without moving parts with efficiency of about 2 per cent compared with the 30 per cent to 40 per cent efficiency of a steam generator in big electric power plants. No immediate commercial applications are foreseen, but a space satellite radio transmitter conceivably might use these materials.

September 5

△ Custom smelters advanced copper prices ¼¢ to 26¼¢ a lb, copper scrap also increased in similar amount.

△ Youngstown Sheet and Tube Co. plans to close and dismantle its 52-year-old bessemer converter plant at the Campbell works, annual rated capacity 240,000 tons.

△ The Bureau of Mines reported that production of Pennsylvania anthracite for August, 1958 amounted to 1,779,000 net tons compared with 1,400,000 in July, 1958 and 2,294,000 in August, 1957.

△ Keystone Steel & Wire Co. reported net sales of $97,706,805 for the fiscal year ended June 30, net income of $5,984,595 or $3.19 per share compared with sales of $112,488,243, income of $8,476,095 or $4.52 a share for the previous fiscal year.

September 8

△ The AISI reports that the operating rate of the steel industry for the week of September 8 is scheduled at 1,764,000 tons (65.4 per cent of capacity). This compares with 1,666,000 tons one week ago (61.7 per cent capacity) and 2,097,000 tons one year ago. Index of production for the week is 109.8.

△ Republic Steel Corp. received an order for 94,000 tons, or 450 miles, of 24-in. diam pipe from Houston Corp. for a new natural gas line running from Texas to Florida.

September 10

△ Government agencies reported that unemployment for the month ended August 15 fell to 4,700,000, down 600,000; employment rose to a level of 65,400,000, an increase of 200,000.

September 11

△ The AISI reports that shipments of finished steel products in July, 1958 totaled 4,081,744 net tons compared with 5,746,217 tons in June, 1958 and 5,877,133 tons in July, 1957; shipments for the first seven months of 1958 were 32,772,920 net tons compared with 50,162,861 net tons during the same period of 1957.

September 12

△ William A. Jahn, president of Inland Steel Products Co., a subsidiary of Inland Steel Co., announced that his company had purchased the machinery of Gabriel Steel Co., Detroit and will take over Gabriel's sales and productions at the end of September.

△ According to the Administrations latest estimate the deficit for the year ending June 30, 1959 will amount to $12,200,000,000; the January prediction was a surplus of $300,000,000 would be accrued.

△ The AISI reports that steelmaking furnaces in the U. S. produced 7,285,000 net tons of ingots and steel for castings in August, 1958 compared with 6,420,405 tons during July, 1958 and 9,233,890 tons during August, 1957.

September 15

△ National Steel Corp. has announced establishment of a stock investment plan for salaried employees, effective October 1, 1958. The plan will be operated through a trust agreement between the Corp. and the Fidelity Trust Co. of Pittsburgh. All full time salaried employees with one year continuous service of the corporation or its subsidiaries are eligible with the exception of those holding stock options; amounts are payable through regular payroll deductions from 1 to 7½ per cent of employee's total compensation, which will be matched dollar for dollar by the corporation for purchase of National Steel stock.

△ Starts of private housing during August, 1958 rose to an annual adjusted rate 1,170,000 units, 10,000 above the July pace; applications for FHA insurance on proposed new homes climbed to 33,600, 1900 over July.

△ The AISI reports that the operating rate of the steel industry for the week of September 15 is scheduled at 1,797,000 tons (66.6 per cent of capacity). This compares with 1,780,000 tons (65.9 per cent capacity) one week ago, and 2,101,000 tons one year ago.

September 16

△ The Commerce Dept. reported that personal income in August, 1958 rose to a yearly rate of $355,600,000,000, which is $1,400,000,000 above the July, 1958 pace and $3,500,000,000 over the rate in August, 1957.

△ David J. McDonald, president of USW, threatened general shutdowns next year as union delegates met in Atlantic City to draw up demands to be presented at the expiration of the present three-year contract in mid-1959, if steel producers want a strike.

September 17

△ U. S. Custom smelters increased quotations on copper ⅛¢ a lb, to 26⅜¢; in London spot copper price advanced about ⅛¢.

September 18

△ Ford Motor Co. and UAW signed a 3-year contract. Among the benefits of the new contract were supplemental unemployment benefits, pensions, and higher wages of skilled workers; Ford also agreed to severance pay for workers displaced by plant transfers or closings.

△ Custom smelters increased price of copper ⅛¢ a lb to 26½¢.

△ Price of lead increased ¼¢ to 11¢ a lb.

△ The ARCI reports that deliveries of new domestic freight cars in August, 1958 totaled 2151 compared with 2113 in July, 1958 and 8758 in August, 1957. Orders in August totaled 1773 compared with 376 for July, 1958 and 2928 in August, 1957. Backlog of cars on order as of September 1, 1958 stood at 25,611 compared with 25,994 on August 1, 1958 and 79,258 on September 1, 1957.

September 19

△ Prices of tin dropped 11¢ a lb in London and nearly 9¢ a lb in New York following suspension of supporting operations by the International Tin Council.

September 20

△ The Aluminum Assn. reported primary aluminum production in the United States during August, 1958 was 125,419 short tons compared with 118,541 short tons in July, 1958 and 143,448 tons in August, 1957.

September 22

△ The AISI reports that the operating rate of the steel industry for the week of September 22 is scheduled at 1,793,000 tons (66.4 per cent of capacity). This compares with 1,771,000 tons one week ago (65.6 per cent capacity) and 2,105,000 tons one year ago. Index of production is 111.6.

△ The Industrial Heating Equipment Assn. reported that new orders for industrial furnaces in August, 1958 were $3,533,000 compared with $3,924,000 in August, 1957. New orders for induction heating equipment in August totaled $383,000, compared with $1,350,000 in August, 1957.

△ West Germany's crude steel production for July, 1958 amounted to approximately 1,922,000 metric tons, compared with 2,066,000 in July, 1957. Figures for August are approximately 1,860,000 net tons in 1958 compared with 2,121,000 in August, 1957.

△ The Bureau of Mines reported that the consumption of scrap during July, 1958 totaled 3,718,000 gross tons, pig iron used was 3,821,000 gross tons; this compared with 4,409,006 tons of scrap and 4,058,714 tons of pig iron in June, 1958.

△ The Bureau of Mines, Dept. of the Interior, reported that net shipments of steel mill products during 1957 totaled 80,211,365 tons, compared with 84,283,716 tons in 1956; production of ingots in 1957 amounted to 112,629,554 tons compared with 114,969,422 tons in 1956.

△ U. S. Steel Corp., Tennessee Coal and Iron Div. announced an average increase of approximately 3.5 per cent for tin mill products, effective November 1; mill price bases at Gary, Irwin, Fairless and Fairfield plants will be increased 35¢ per base box for electrolytic and hot dipped tin plate, black plate and terne plate; Columbia-Geneva will increase mill price bases 25¢ per base box at Pittsburg, Calif.

△ Workers drawing jobless pay for the week of September 6 totaled 2,040,000, down 45,700; in the week of September 13, initial claims for unemployment compensation fell 3700 to a total of 259,200.

September 23

△ Annual imports of lead and zinc will be limited to 354,720 tons of lead and 520,960 tons of zinc or 80 per cent of average commercial imports during 1953–57 under a new quota system imposed by President Eisenhower. Based on figures of the first six months, the Bureau of Mines officials estimated imports this year would have reached 635,645 tons of lead and 712,328 tons of zinc, if quotos had not been established.

△ Machine tool makers reported incoming orders for the industry declined to $18,900,000, compared with $20,900,000 in July, 1958 and $44,500,000 in August, 1957.

September 25

△ The AISC reports that bookings of fabricated steel in August, 1958 totaled 225,768 tons compared with 330,890 tons in July, 1958 and 183,520 tons in August, 1957; shipments in August, 1958 totaled 298,012 tons compared with 290,856 tons in July, 1958 and 383,785 tons in August, 1957. Backlog of future work as of August 31 totaled 2,119,074.

△ American Can Co. announced it would abandon its practices of applying flat percentage increase uniformly across the board, but would adjust prices on each type and style of can, effective November 1 due to increase in cost of tin plate.

△ International Nickel's operations were halted by walkout of 14,000 workers to enforce contract demands.

September 26

△ The Assn. of American Railroads reported that car loadings totaled 667,277 for the week ended September 20 compared with 665,999 cars in the previous week.

September 29

△ The AISI reports that the operating rate of the steel industry for the week of September 29 is scheduled at 1,850,000 tons (68.5 per cent of capacity). This compares with 1,816,000 tons one week ago (67.3 per cent capacity) and 2,115,000 tons one year ago. Index of production for the week is 115.2.

△ Steel industry projections of 1959 production, range from 20 to 30 per cent above 1958 expected output of about 85,000,000 tons.

△ F. W. Dodge Corp. reports that construction contracts in the U. S. during August, 1958 totaled $3,466,576,000, 23 per cent over August, 1957.

September 30

△ The Aluminum Assn. reported that shipments of aluminum sheet and plate in August, 1958, totaled 91,924,000 lb, compared with 103,581,000 lb in July, 1958; shipments of aluminum foil in August, 1958 totaled 16,583,432 lb, compared with 14,455,039 lb in July, 1958.

△ Federal Reserve figures showed that consumers stepped up instalment buying in August, and seasonally adjusted instalment credit outstanding rose $30,000,000.

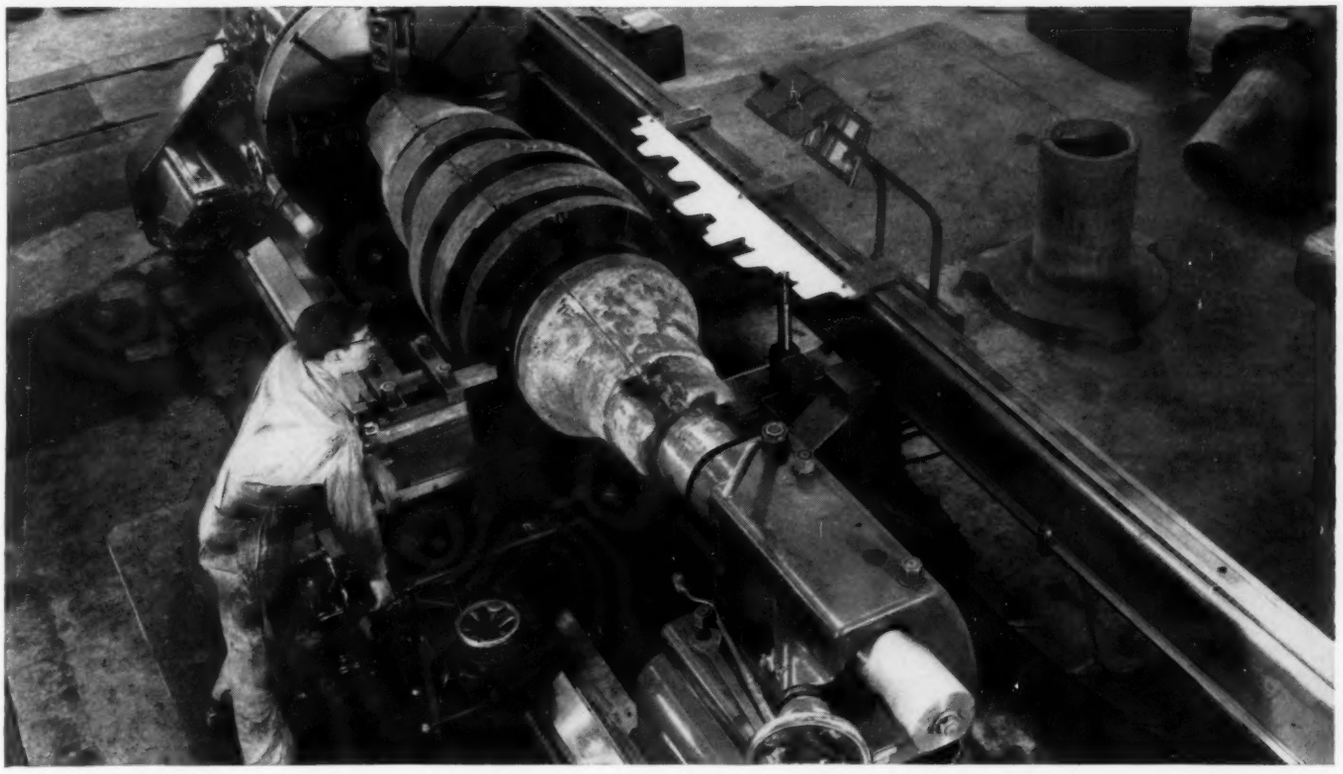
△ Lead increased ½¢ to 11½¢ a lb in New York.

△ The Commerce Dept. reported that manufacturers sales in August, 1958 increased to $26,400,000,000, an increase of $100,000,000 over July, 1958, and $2,200,000,000 under August, 1957.

△ Shipments of iron and steel castings for July, 1958 totaled 902,227 short tons compared with 1,012,691 tons in June, 1958 and 1,133,868 tons in July, 1957.

PROGRESS IN ROLL MAKING

contour turning of iron and steel rolls



NEW—

THIS MODERN CONTOUR LATHE, one of the largest made—50" x 24'—is the latest addition to the roll shop at National. Equipped with a complete hydraulic contour attachment, this lathe machines the largest rolls, accurately and quickly to exact specifications.

Plant expansion and new equipment are the keynote at National—all planned to give you better iron and steel rolls—when you need them and for all rolling mill operations.

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National Roll & Foundry Division

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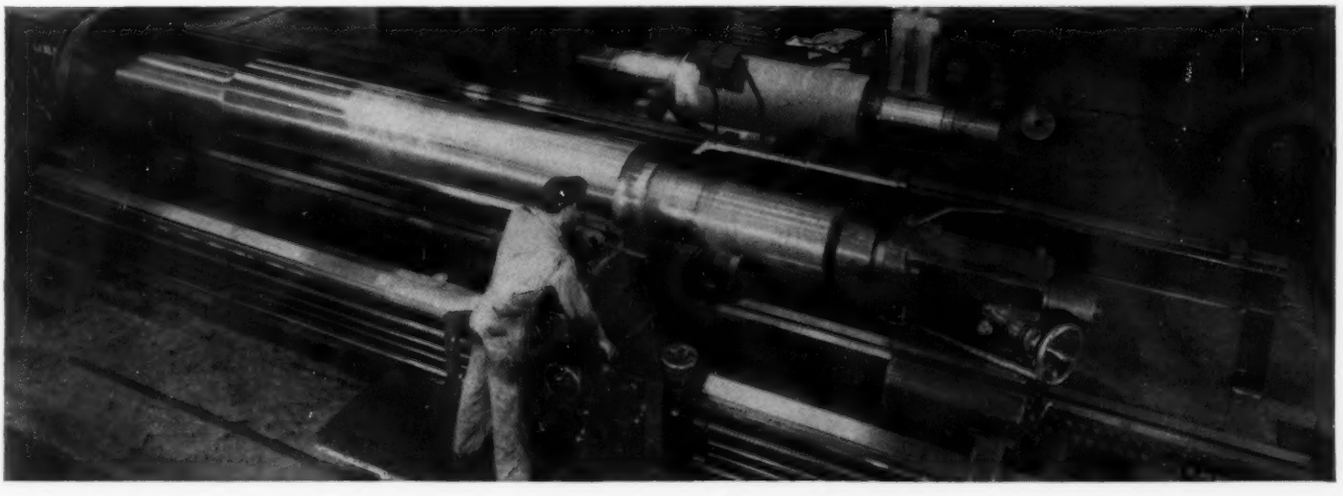
General Steel Castings Corporation: General Offices, Granite City, Ill.
Plants: Granite City, Ill.—Eddystone, Pa.—Avonmore, Pa.



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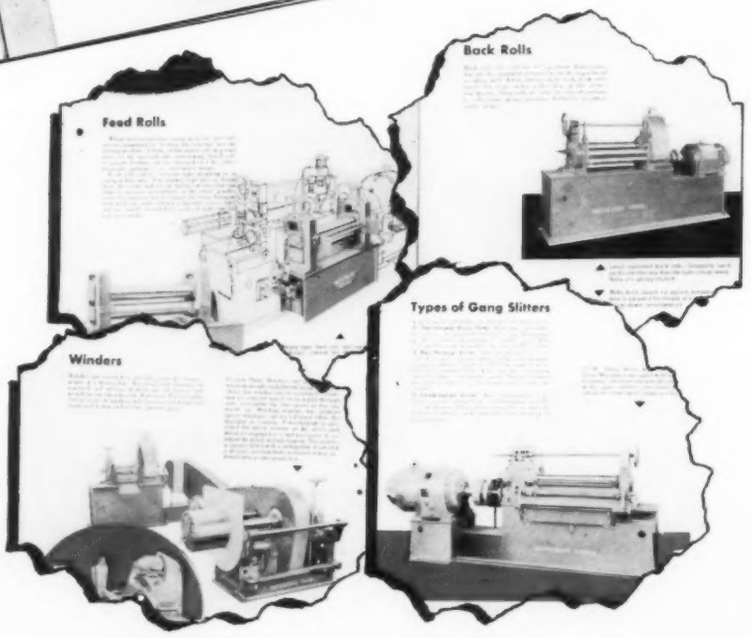

Covers extensive line of WF slitting equipment for warehouse and factory use. Sizes range from small hand-operated slitters with 3" diameter cutters to fully automatic slitting lines with 16" diameter cutters.

Gives details on various slitter types as well as payoffs and coil boxes, loaders, straighteners, feed rolls, back rolls, cutters and spacers, stripper fingers, winders and coilers. Includes specifications and cutting capacity chart. Send for your copy.

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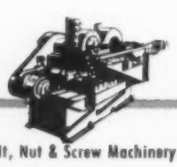
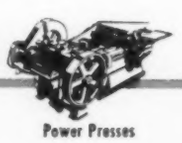
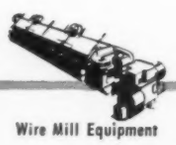
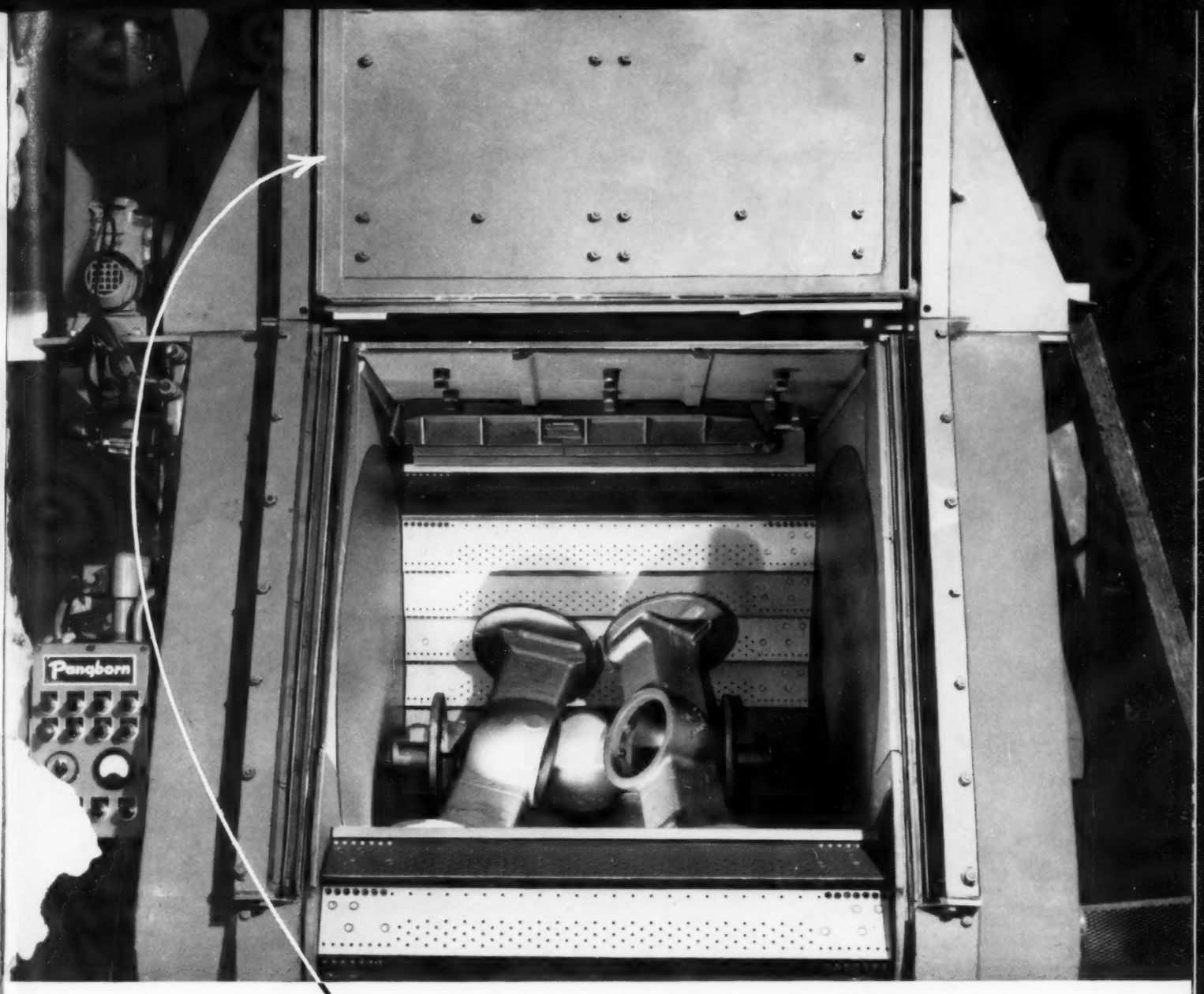

Bolt, Nut & Screw Machinery


Power Presses

Rolling Mill Machinery


Wire Mill Equipment

Sendzimir Mills & Other Special Machinery



When this door comes down . . . so does your blast cleaning cost!

Abrasive-tight door on Rotoblast Barrel slashes "lost abrasive" costs

Look at it. That door on the Pangborn Rotoblast Barrel is engineered to prevent waste. Heavy steel plates . . . an exclusive arrangement that permits raising the door for easy maintenance . . . *clamp*-closing to make it really abrasive-tight! As a result, here is another way that Pangborn Rotoblast Barrels save you money.

This door is just one of the many benefits built into Rotoblast Barrels. Efficient Rotoblast operation, for example. Automatic control. Ease of maintenance. Plus specific construction features that all add up to *better* cleaning in *less* time for *lowest* cost per ton.

Pangborn Rotoblast Barrel for efficient batch cleaning. Available in 1½, 3, 6, 12, 18, 20, 32, 72 and 102 cubic foot sizes.

The Pangborn Engineer in your area will be glad to take off his coat and go to work on your cleaning problem at no obligation. And for complete information on Rotoblast Barrels, write to: Pangborn Corp., *4400 Pangborn Blvd., Hagerstown, Md. Manufacturers of Blast Cleaning & Dust Control Equipment.*

Clean it fast with Pangborn ROTOBLAST®

A painter prompted a new look

When one of our maintenance department painters was redecorating the treasurer's office, he asked about U.S. Savings Bonds. "If I could buy these Bonds on installments," he said, "and you could take my payments out before I got my paycheck, I'd hardly miss it."

Our treasurer explained that the Payroll Savings Plan does exactly that and gave the painter an application card. But the matter didn't end there, for our painter had given *us* something, too: an idea that helped to put real color into our plan.

He made us realize that if he was unfamiliar with this plan, many others must be in exactly the same position.

Our State Savings Bond Director helped us pass the word. Under his direction, we set up a company-wide campaign that gave the whole Payroll Savings story to every person in the Company. Within a few days we had the best employee participation we've had since the mid-forties.

People are quick to take advantage of this sound, automatic way to save money. Today there are more payroll savers than ever before in peacetime. Look up your State Director in the phone book or write: Savings Bonds Division, U.S. Treasury Department, Washington, D.C.

IRON AND STEEL ENGINEER

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Will be used in rolling aluminum foil

Here's a good example of a medium-sized roll made by Bethlehem to customer specifications. We started with blueprints; melted the steel, forged the ingot, did the necessary preliminary treatment, machined and hardened the forging, and ground it to the specified contours and finish.

This roll weighs approximately 13 tons; has a maximum diameter of 35½ in. and a face of 72 in. Designed for use in the making of aluminum foil, it will serve as a back-up roll in a four-high mill.

We suggest you call us when you need forged, hardened rolls for this and similar kinds of service. Bethlehem is ready to meet any requirements on size, hardness, finish, and other details. Let us quote you whenever your operations involve cold-rolling ferrous sheets and strip . . . running down and finishing copper and brass sheets . . . hot- and cold-rolling aluminum sheets . . . cold-rolling aluminum foil.

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BETHLEHEM STEEL

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presents

SCHLOEMANN

Rolling mills
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Automatic five-tube tester

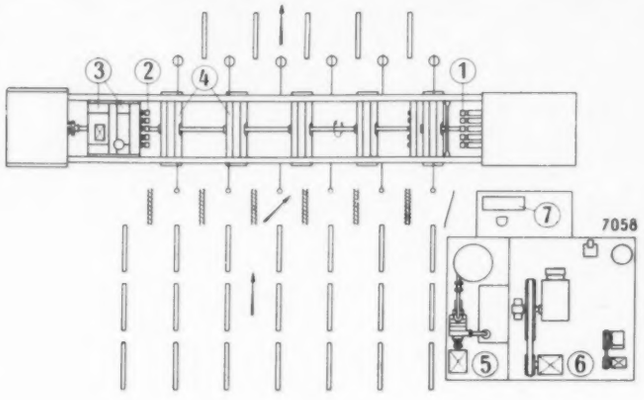
For the past forty years SCHLOEMANN have been building hydraulic machinery for tube finishing, in particular, testers for steel, cast iron and non-ferrous tubes, with testing pressures up to 14,000 PSI. The demand for high production and simple but reliable means of operation has led to the development of a five-tube tester of novel design.—Two SCHLOEMANN testers are already in operation in the United States, and others are being manufactured.

Testing plant

The tester is of welded construction. Ten tester heads are provided for clamping and releasing the tubes, five of which can be moved individually and hydraulically ①, and five jointly by toggle-lever action ②. The movable carriage ③ is motor-driven for quick adjustment, and can be fastened within the tester frame for varying tube lengths when the testing program is changed. The tubes can be sealed either by face-rings or o.d. packings. A holding device prevents axial displacement of the tubes.
An integral tube charging and discharging device is arranged on a common shaft. It consists of several traversing pairs of discs ④ which rotate stepwise and to which tube-holders are attached. The tube-holders can be easily adjusted collectively for quick change-over to new tube size. During testing, the tubes are stationary.

Drive and controls

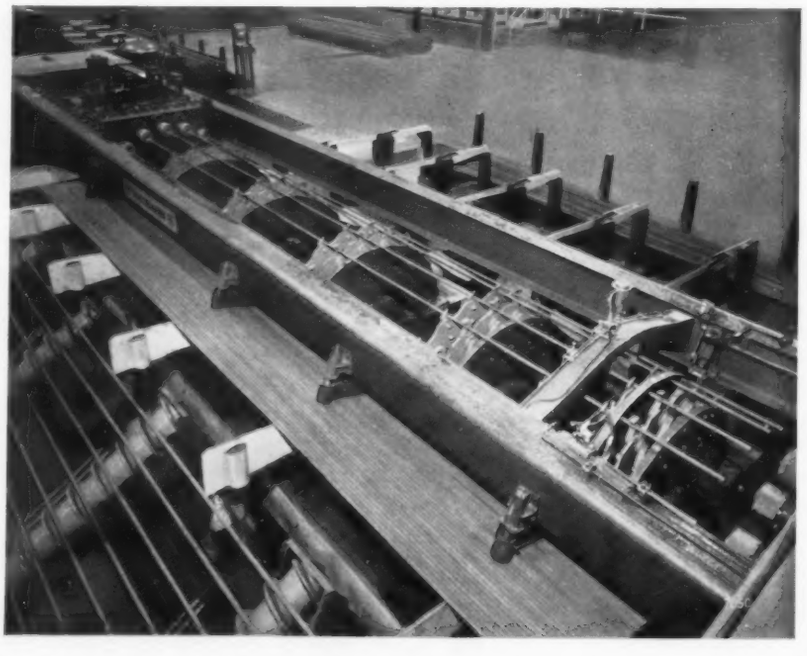
The tester has individual drive, consisting of a prefill system ⑤ and a high-pressure system ⑥ each with its own accumulator and pump. A separating piston prevents contamination of lubricated pressure water by testing water and loss during testing. The tester is electrohydraulically controlled from the desk — either automatically or by hand.



Layout of an automatic five-tube tester.

Technical data

Standard types	A	B
Tube i.d.	½″ to 2″	½″ to 4″
Length of tube	17 ft. to 25 ft.	17 ft. to 50 ft.
Tolerance in length	6″	6″
Max. testing pressure	1,500 PSI	2,300 PSI
Max. hourly capacity at 3 sec holding time	1,500 tubes	1500 tubes



Five-tube tester in operating position. (Photograph by courtesy of Jones & Laughlin Steel Corporation) The operator can clearly observe the tubes and mark leakage points on them from the control stand.

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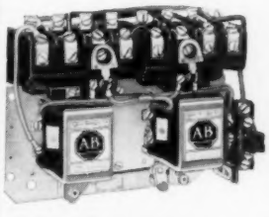
CONTACTORS

Bulletin 202 solenoid type contactor. In ratings to 150 amp. Also, clapper type to 600 amperes.

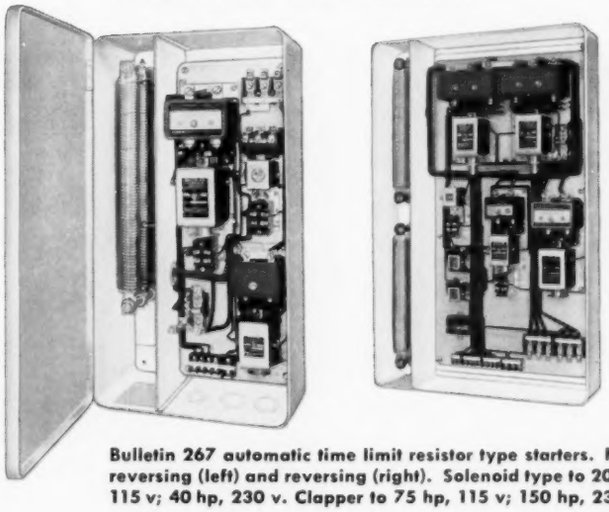
FULL VOLTAGE STARTERS



Bulletin 205 full voltage reversing starter. Ratings to 1½ hp, 115 v; 2 hp, 230 v.

Bulletin 209 full voltage starter. Available in ratings up to 1½ hp, 115 v; 2 hp, 230 v.

REDUCED VOLTAGE STARTERS



Bulletin 267 automatic time limit resistor type starters. Non-reversing (left) and reversing (right). Solenoid type to 20 hp, 115 v; 40 hp, 230 v. Clapper to 75 hp, 115 v; 150 hp, 230 v.

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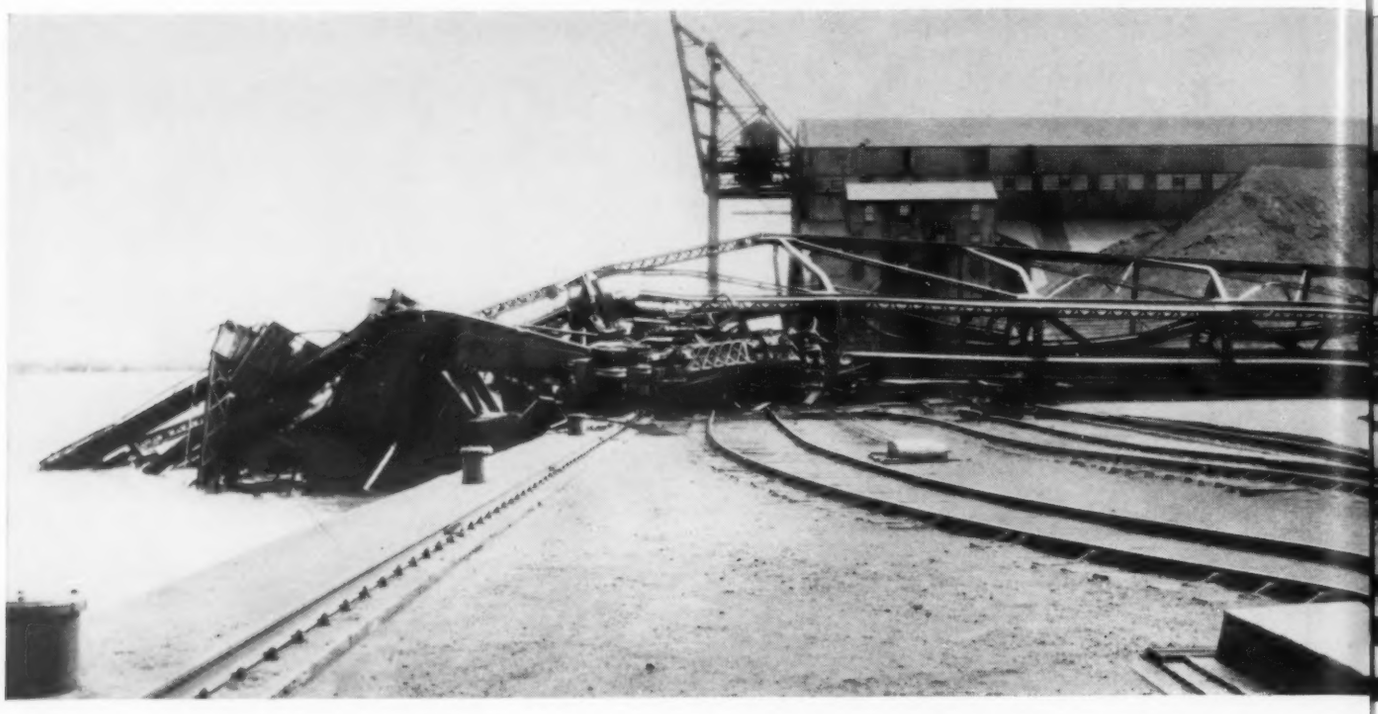
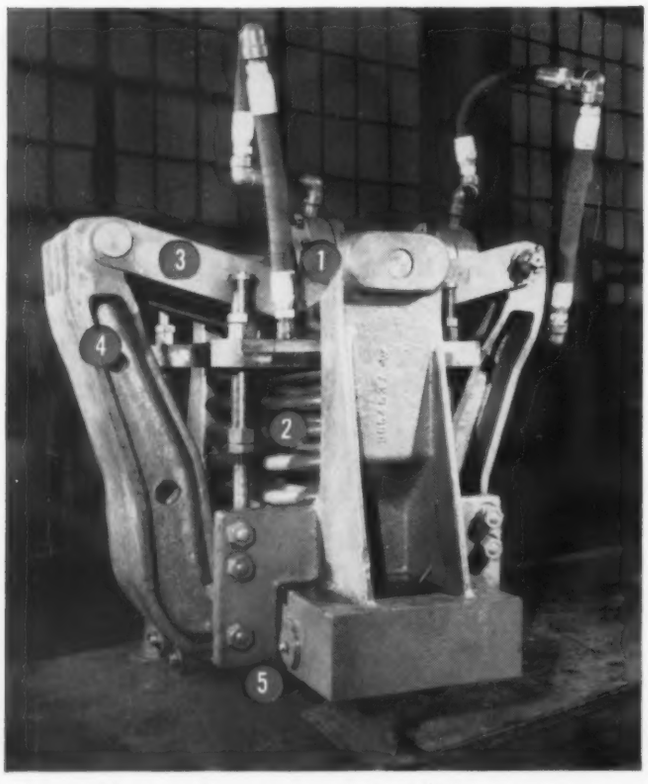
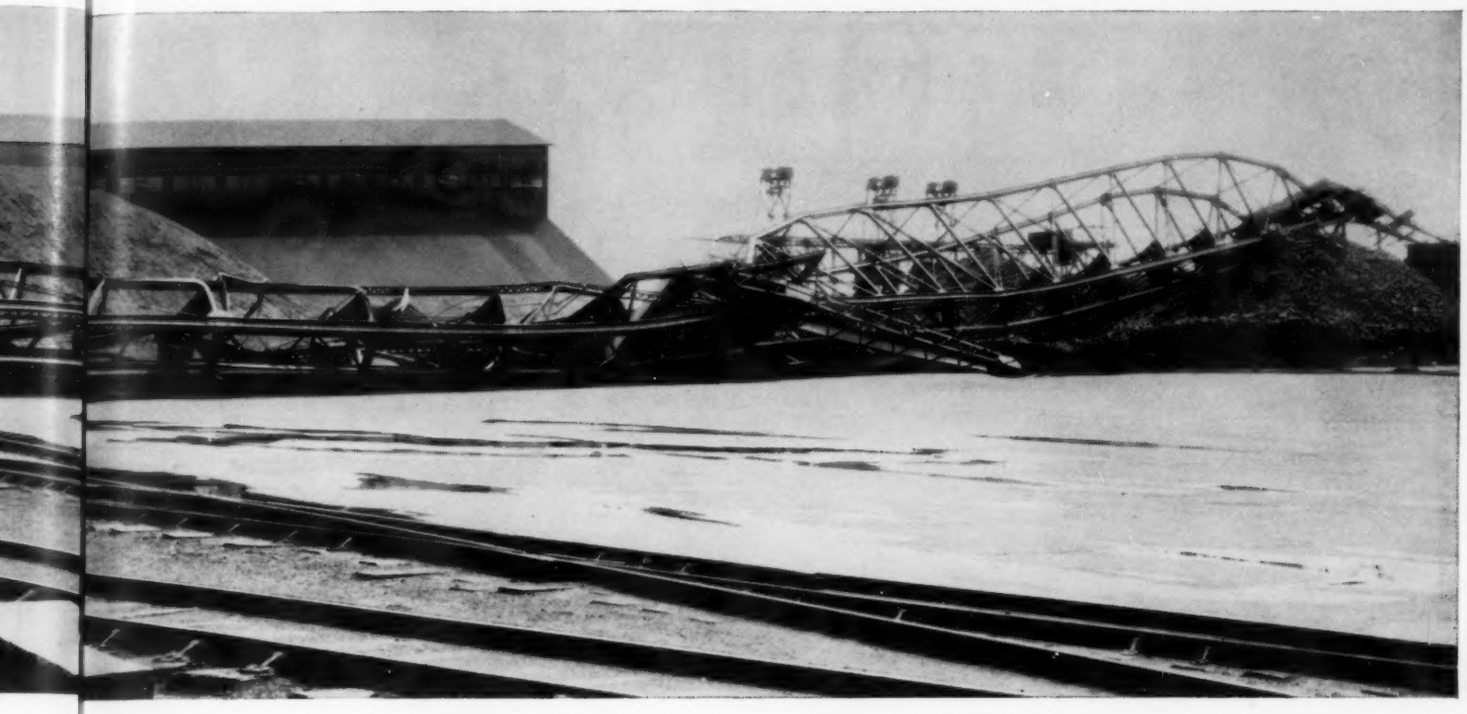
HOW MUCH WILL YOUR ORE BRIDGE BE





During bridge travel, hydraulic cylinder (**1**) keeps heavy helical springs (**2**) compressed, holding clamp in released position. When winds reach a predetermined level, or when travel motors are not operating, pressure is automatically released from the cylinder. This allows the springs to force the toggle arms (**3**) upward, spreading lever arms (**4**) and forcing jaws (**5**) against the railhead at tremendous pressure. Gripping jaws are easily and quickly replaced by removing two bolts (**6**) from each jaw. Clamp assembly rolls along rail on hardened-steel wheels (**7**). Jaws never rub against railhead.

WORTH AFTER THE NEXT WIND STORM?



NEW DRAVO *GALE-GUARD* RAIL CLAMPS PREVENT SLIPPAGE IN 100 MPH WINDS

Almost every year high winds make a million dollar junk pile out of some busy ore bridge. Dravo's new *Gale-Guard* rail clamps can keep this from happening to you. Here are facts you should know immediately about this new rail clamp design.

HOLDING POWER: The new *Gale-Guard* clamps will hold a bridge or unloader stationary in winds in excess of 100 mph. Special replaceable jaws with hardened-steel rail-gripping teeth assure maximum holding power.

AUTOMATIC OPERATION: Controlled by an anemometer, *Gale-Guard* clamps automatically lock the structure to the rails if winds exceed a predetermined velocity.

APPLICATION: Standard on all Dravo ore bridges and unloaders, *Gale-Guard* rail clamps are also available for quick, economical installation on existing equipment.

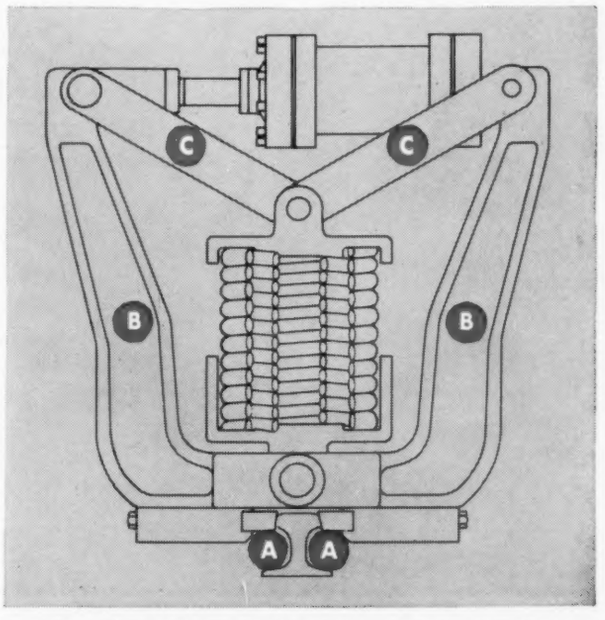
NO ADJUSTMENTS NEEDED: *Gale-Guard* rail clamps automatically increase holding pressure to compensate for long-term jaw wear and railhead variation. Operator adjustment is never necessary. See drawing at right.

MAXIMUM JAW WEAR: *Gale-Guard* rail clamps roll along the rail on hardened-steel wheels. This means that the open jaws never rub against the railhead during travel.

LOW, EASY MAINTENANCE: *Gale-Guard* rail clamps need little maintenance other than occasional jaw replacement. This is simple since each jaw can be replaced in a matter of minutes by loosening two easy-to-get-at bolts.

SAFETY INTERLOCK: Clamps are automatically set at all times except when the structure's travel motors are operating. In case of power failure, the clamps automatically lock the bridge or unloader to the rails.

PRICE: Because of the outstanding features and high-quality workmanship of the new *Gale-Guard* clamps, cost may be slightly higher than other devices.



Gale-Guard rail clamps automatically compensate for jaw wear or railhead variations. As jaws (**A**) wear, spread of lever arms (**B**) increases. This causes the angle of the toggle arms (**C**) to flatten, thus increasing jaw pressure at the railhead.

FOR MORE INFORMATION:
Contact Dravo Corporation, Pittsburgh 25, Pa.

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OR20

Industry News...

NEW BLOOMING AND STRUCTURAL MILL NOW UNDER CONSTRUCTION AT SOUTH WORKS

△ United States Steel Corp. has under way the construction of a new blooming and structural mill at its South Works, Chicago, Ill. The ultramodern mills will produce standard structural and wide flange beams of the lighter weights, which are in great demand by the construction industry.

The new facilities will consist of a blooming mill for primary rolling operations with new soaking pits, reheating furnaces, a secondary or breakdown mill, and a cross country 4-stand structural mill. This mill unit will replace two obsolete blooming mills and two obsolete structural mills.

The capacity of the structural mill will be considerably greater than the old mill complement. In addition, the installation should increase the output of the present 52-in. wide flange beam mill by relieving it of the production of lighter weight sections which, when rolled on this mill, have the effect of decreasing its over-all production.

The new mill unit will have many features which are unique and which will contribute to its versatility. For instance, it will be possible to replace mill stands to permit rapid changing from structural shapes and semi-finished products to wide flange beam sections.

Four single stands will be used for rolling standard structural shapes and semi-finished products. When wide flange beams are rolled, the single stands will be replaced by three 2-stand and one single stand Universal units. The 2-stand units include both horizontal and edge rolling components.

Operation of the mill will be controlled by an electronic card-reading and control system with no moving parts. This system will perform automatically such operations as the positioning of all mill screws; the adjustment of all main motor speed settings; the positioning of side guards; manipulators and fingers; and the re-entry of the piece being rolled in all reversing stands.

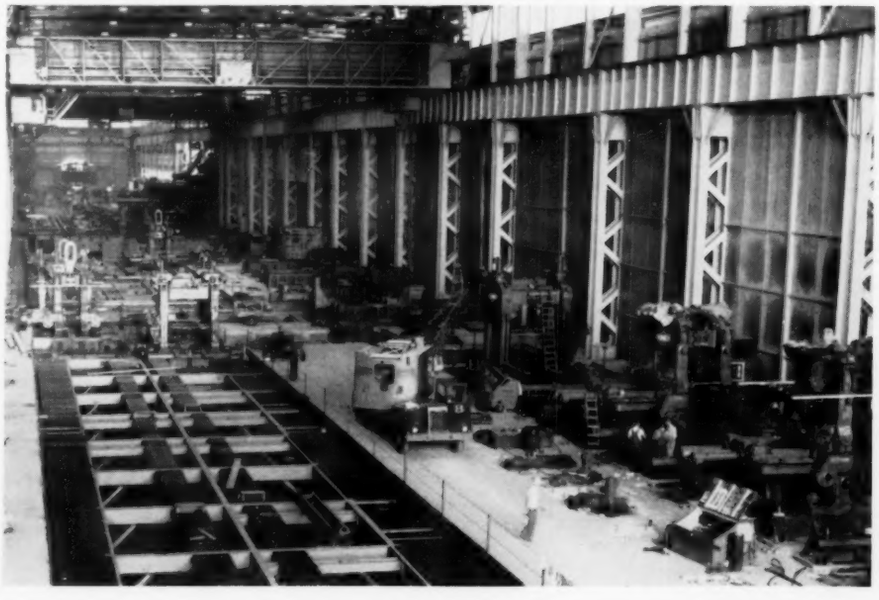
The blooming mill for the plant is being built by United Engineering & Foundry Co. with controls by Westinghouse Electric Corp. Programmed functions include screw-down opening, entry speeds and acceleration rates. The bloom will be automatically turned and manipulated.

Structural stands are being built by Blaw-Knox Co. with controls by General Electric Co. Twenty-three functions are being programmed. Separate cards will control individual stands but programs will be tied together in complementary fashion.

U. S. Steel is working toward a highly organized flow of steel from bloomer through finishing stands. Linear programming techniques are being used to come up with best mill utilization.

Steel for both the blooming and structural mill buildings was rolled at South Works. American Bridge Division of U. S. Steel designed, fabricated and is erecting the steelwork.

View from end of main building of U. S. Steel's new structural mill at South Works in Chicago. Holes in floor are left for finishing rolls which are yet to be installed. At right are mills for rolling structurals and shapes.



J&L ADDS FACILITIES AT DETROIT WAREHOUSE

△ New facilities have been installed at Jones & Laughlin Steel Corp.'s Detroit, Mich., warehouse for slitting and banding a wide range of steel and aluminum.

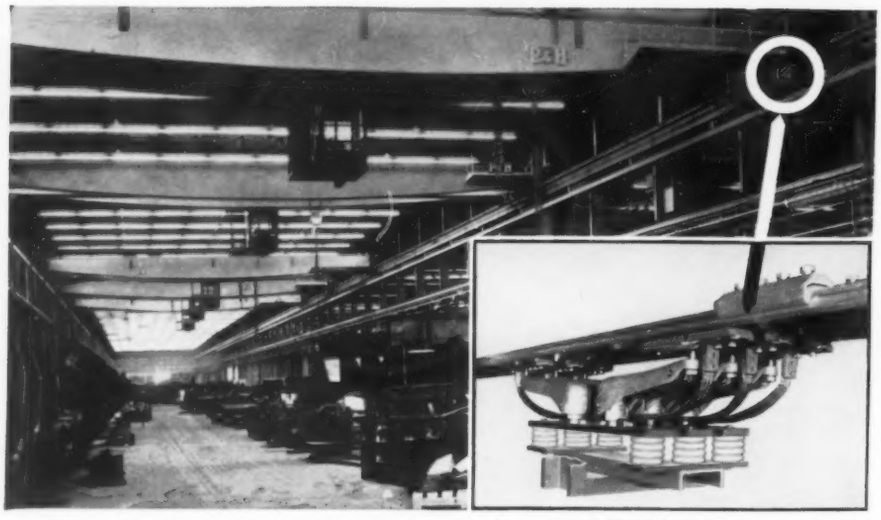
With the new equipment, coils of hot rolled, hot rolled and pickled, cold rolled, galvanized, long terne, black plate, tin plate, stainless steel and aluminum can be processed to customer specifications.

The new slitting line can handle coils with inside diameters of 16 in. and larger. It is equipped with precision x-ray gaging equipment for closely-controlled tolerances, and includes an automatic bander.

Capacity of the slitting unit is 49 in. in width. Coil weight capacity is 15,000 lb at speeds up to 450 fpm. Heavier coils can be processed depending upon the outside diameter dimension.

A 12-in. auxiliary slitting line also has been installed for small coils and short runs to provide for a wider and more flexible range of operation.

Finished coils are banded to a predetermined tension by the mechanical banding machine, producing a uniform package which is a definite



Close-up of Delta-Star Integrated Crane Conductor System with 500a collectors.

PRR SAVES CRANE COSTS, UPS EFFICIENCY with DELTA-STAR Integrated Crane Conductors

Fifteen overhead cranes are powered from this 2760-ft. DELTA-STAR 3-rail conductor system in the Pennsylvania Railroad's new freight-car-repair shop at Hollidaysburg, Pa.

With aluminum conductor systems in place of steel, PRR has engineered savings in many categories:

SAVED TRANSFORMERS • The aluminum systems eliminated three transformer substations needed with steel conductors.

SAVED FEEDER RUNS • Only the center tap was needed with this non-magnetic system.

SAVED BOOSTER CABLES • Cranes operate a quarter mile from feeder without boosters.

BETTER PERFORMANCE • Close conductor spacing and system characteristics minimize voltage drop, improving crane performance, reducing motor breakdowns.

LOWER OVER-ALL COSTS • Integrated package design, lightweight components, adequate voltage supply —these cut engineering and installation costs, continuously reduce operating expense for PRR.

Similar DELTA-STAR Integrated Systems are in use *on runs as short as 50 feet*, with voltages to 4160 and amperages to 6000, on cranes, ore bridges, ship unloaders, etc. Standard systems are available to meet *your* needs; aluminum, bronze, or copper conductors including enclosures. Call your nearest Delta-Star representative, or write *Dept. 557 Delta-Star Electric Division, H. K. Porter Company, Inc., 17th & Cambria Sts., Philadelphia 32, Pa. District offices in principal cities.*

H. K. PORTER COMPANY, INC.
DELTA-STAR ELECTRIC DIVISION

advantage to customers in further handling. Supplementary handling and banding equipment makes all special coil packaging requirements possible.

TIMKEN WILL INSTALL NEW PIERCING MILL

△ At a cost of an estimated one and one half million dollars the Steel and Tube Division of The Timken Roller Bearing Co. will install a new piercing mill at its Gambrinus location.

The new unit will be combined with existing Gambrinus piercing mill operations permitting the Timken Co. for the first time to "double pierce." The new producing facilities will make it possible to produce hot rolled tubing with thinner wall dimensions in both stainless and alloy grades as well as improved inner surface and center wall quality. The use of this equipment should open new markets for the Timken Co., particularly in the power production, chemical and nuclear fields where high temperature, high pressure tubing is needed. Lead time normally required in production of tubing in this category will be reduced substantially, permitting quicker delivery of customer's order.

Installation of the new mill will necessitate rearrangement of existing facilities. An addition of 180 ft will be made to the present tube mill building and the 72-ft rotary furnace will be moved into the new extension. Existing machinery and the new piercing mill will be installed in the proper sequence with the rotary furnace as the starting point.

The bulk of the work is expected to be done in July of 1959. The new equipment is part of the $51 million expansion and modernization program taking place during the next five years.

VALVE FIRM ANNOUNCES NEW COMPANY NAME

△ N. A. Pedersen, president of C. B. Hunt & Son, Inc., Salem, Ohio, announces that the company has changed its name to Hunt Valve Co., to identify its name more closely with its products.

Several new control valves, fully designed and now undergoing final tests, are expected to be introduced within the next few months.

BEST OF THE HEAVIES...

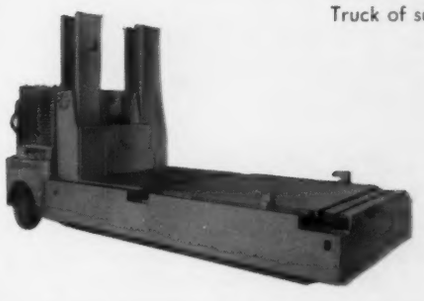
SERIES MF-ELBOLIFT: Works on leverage principle new to lift truck design... eliminates entire mast assembly. Carrying a load of 15,000 lbs., the Elbolift passes easily through any 78" boxcar door... will right-angle stack a 52" long load up to 120" high comfortably in a 13' 8" aisle. CAPACITIES: 12,000 to 20,000 pounds.

Automatic...
Most Complete Line of Steel and Die Handling Equipment
Capacities up to 110,000 lbs. or more

In the heavyweight division of materials handling, no other line matches the versatility and range of Automatic's heavy duty trucks. This is the direct result of many years of specialized engineering and manufacturing experience in the coil and die handling field. The five examples shown here comprise only a small sampling of the wide range of heavy duty handling requirements served by Automatic equipment. So don't hesitate to call us in on any problem involving weights up to any practical limit. No obligation, of course. Just mail the coupon.

COIL-UPENDER ATTACHMENT: Picks up coil in vertical position and rotates to horizontal or vice versa. Holds coil securely throughout rotation... prevents telescoping. Handles up to 60,000 lbs. Now available on Automatic HR Series or as an attachment for any Automatic Truck of suitable design and capacity.

SKYLIFT GIANT: Heavy duty mast type truck available with either forks or ram. Model shown here has split ram to handle either 1 or 2 coils at a time. CAPACITIES: 20,000 through 80,000 pounds or more.



SERIES TLO: First heavy duty die handlers ever made with completely hydraulic loading, unloading and lift. Bullards move much faster and smoother than in any mechanical system... unloads at end or either side to meet any requirements of space and accessibility. CAPACITIES: 4,000 to 110,000 pounds or more.

MODEL TLO-10: Shortest, most compact 20,000 pound die-handler made... fastest, easiest to maneuver, especially in narrow aisles. Hydraulically operated lift, loading and unloading.

Automatic Electric Industrial Trucks Cost Less to Own... Less to Operate

AUTOMATIC TRANSPORTATION COMPANY
Division of The Yale & Towne Manufacturing Company
47 West 87th Street—Dept. T-8—Chicago 20, Illinois

Electric Automatic Industrial Trucks

WORLD'S LARGEST EXCLUSIVE BUILDERS OF ELECTRIC-DRIVEN INDUSTRIAL TRUCKS

AUTOMATIC TRANSPORTATION COMPANY
Division of The Yale & Towne Manufacturing Company
47 West 87th Street, Dept. T-8, Chicago 20, Illinois

☐ Please rush me complete specifications on following Automatic heavy duty equipment.

MODELS.....

Your Name.....Title.....

Firm.....

Address.....

City & Zone.....State.....

TO FURNISH SYSTEMS FOR NEW INDIAN MILL

△ Dravo Corp. has been awarded a contract to supply five custom-engineered oil lubricating systems for installation on a new merchant and rod mill to be erected at Burnpur, India, for the Indian Iron and Steel Co., Ltd. The mill will be designed and built by the Morgan Construction Co.

This installation will initially produce merchant product in straight lengths and coiled rod. Provision will be made for the future installation of equipment to finish coiled merchant bar and coiled strip products. The mill consists of 19 roll stands equipped with Morgoil roll neck bearings. A very wide range of high quality products will be produced by the most modern and efficient rolling practice.

The five lubricating systems serving this installation will incorporate features which minimize maintenance and insure continuous operation of the equipment. Each lubricating system will be designed to provide one hundred per cent filtration of the lubricant and to automatically maintain the required flow capacity, operating temperature and pressure of the lubricating oil.

Indicating lamps and audible signals mounted on a centrally located panel, visible from the operating areas, will assure the mill personnel that the lubricating systems are functioning and that all machinery components are being supplied oil at correct pressure and temperature requirements.

for intense concentration of heat...

The BLOOM HTR BURNER

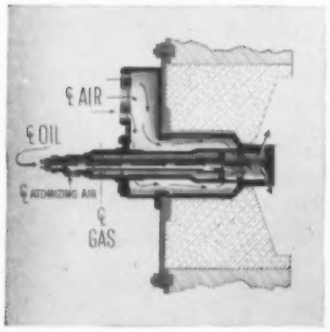
The Bloom HTR Burner provides identical operation on either gas or oil.

This burner enables the engineer to design a heat pattern with excellent results, because it has the unique characteristic of providing localized high heat release with low forward velocity. The burner can be located to fire directly at the material without flame impingement. Roof firing is easily accomplished and provides uniform hearth temperature.

This burner has been very successful in its application to tube upset furnaces; continuous strip annealing, coating, and pre-heating lines; high speed billet heating furnaces; and batch-type forge furnaces.

The Bloom High Thermal Release Burner with its sturdy construction is ideal for applications requiring speed and precision heating.

PATENT PENDING



BLOOM ENGINEERING CO., INC.
837 W. North Avenue Pittsburgh 33, Pa.

SHIP FIRST STAINLESS ORDER FROM LOUISVILLE

△ The first shipment of finished stainless steel was made August 22 from Jones & Laughlin Steel Corp.'s new Stainless and Strip Division Plant at Louisville, Ohio.

John Abbott, division vice president—sales, announced that 10,758 lb of stainless steel sheets, 0.0625 gage, 36 in. x 96 in. Type 302, 2B finish, were shipped to a warehouse customer.

The sheets were rolled on the new 52-in. Sendzimir cold rolling mill which incorporates the latest designs for production and quality control. The $17,000,000 plant, which is nearing completion, will have a monthly capacity of 3000 tons of stainless steel sheet and strip.

ANNOUNCE APPOINTMENT OF NEW SALES AGENT

△ The Pittsburgh Steel Foundry Corp. and their alloy and small castings division, the Fort Pitt Steel Casting Division have appointed the firm of A. T. McKee and Son as sales representatives in the New York State area west of Schenectady.

A. T. McKee was formerly vice president of Strong Steel Foundry, and has been identified with the steel castings industry for 33 years.

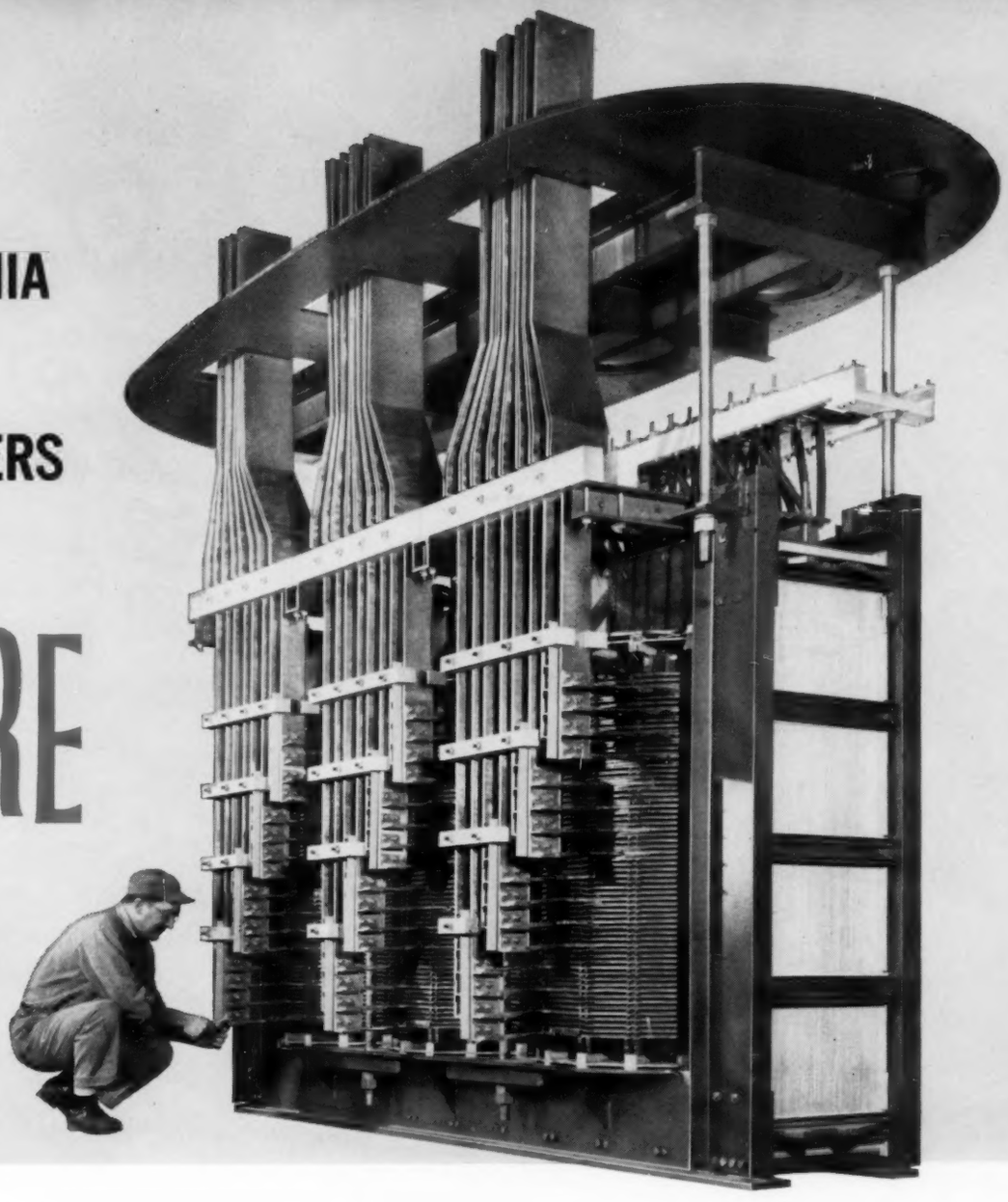
They have established offices at 77 Lowell Rd., Kenmore 17, N. Y.

BUILD FIRST AUTOMATIC JAPANESE ROLLING MILL

△ The Japanese steel industry's first automatic rolling mill is being furnished by Mesta Machine Co. for installation at the Mizue Works of Nippon Kokan K.K. near Tokyo. The new 68-in. semi-continuous hot strip mill will include a two-high scale breaker, a four-high universal reversing roughing mill with front and rear tables, rotary crop shear,

(*Please turn to page 190*)

How PENNSYLVANIA FURNACE TRANSFORMERS take the TORTURE of Year-in, Year-out Service



Furnace transformers are subjected to repeated short circuits and heavy overloads in ordinary service. Distribution of currents and reduction of copper eddy losses also must be given special consideration.

Throughout the years, Pennsylvania Transformer has earned an unsurpassed reputation for meeting these challenges—in installations ranging from 250 through 25,000 kva, and from 3175 through 82,000 amperes. Here are some of the reasons.

Balanced, Precompressed Coils

Coils are balanced to reduce axial short-circuit forces to a minimum . . . and the circular shape protects the coils against deformation by radial short-circuit forces. Also, coils are precompressed with a pressure equal to the maximum short-circuit force that might occur in service. As a result, no additional distortion or displacement can take place.

Bracing of Coils, Bus Bars

Coils are firmly braced, top and bottom, by clamping plates attached to structural steel frames. The accompanying photograph also shows the sturdy supports used for low voltage bus bars. Interleaving of bus bars tends to counterbalance the lines of force and prevent distortion during short circuits.

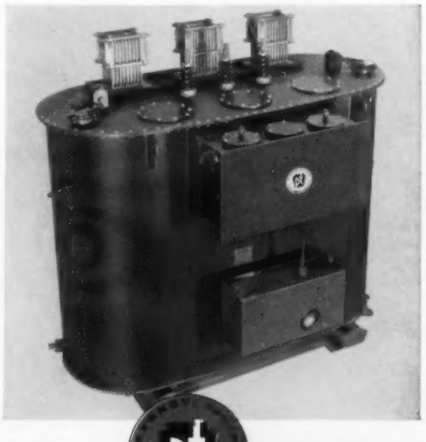
Distribution of Current

Because of the heavy secondary currents, the winding is subdivided into numerous parallel sections. Transposition of the individual conductors of each section reduces copper eddy losses to a minimum. This results in improved efficiency, more uniform copper temperature, and prevention of hot spots.

To take advantage of these and other time-proved features of Pennsylvania Furnace Transformers . . . contact Pennsylvania Transformer Division, McGraw-Edison Company, Box 330, Canonsburg, Pa.

NEW EXTERNALLY-MOUNTED TAP CHANGER

Although a duplicate of a previous order, this 12,000-kva Pennsylvania Furnace Transformer differs from its "twin" in one detail. Its motor-driven tap changer is housed in separate compartments, to facilitate periodic inspection and maintenance. The mechanism includes a provision for emergency hand operation.



PENNSYLVANIA FURNACE TRANSFORMERS

pt

McGRAW EDISON

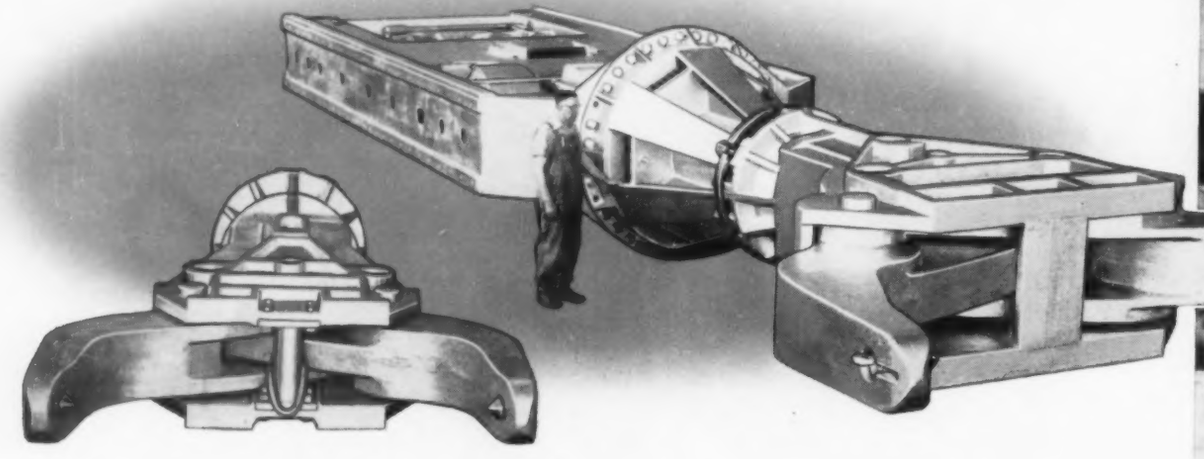
WORLD'S LARGEST

• This 75-ton intensified grip soaking pit crane installed at the Lukens Steel Company, Coatesville, Pennsylvania, has more than twice the capacity of any soaking pit crane ever built.

The complete range of slabs and ingots produced, from 30″ minimum to 125″ maximum, is handled by two tong heads which can be interchanged in a matter of minutes. If your material-handling problems involve big lifts or transfers, Alliance engineers in Alliance or Miami will solve them . . . quickly and economically.

INTERCHANGEABLE TONG HEADS

• To afford better visibility when handling small ingots, the small tongs can quickly be installed on the column. These small tongs have a range of 30″ minimum to 86″ maximum. Range of the large tongs is 65″ minimum to 125″ maximum.



THE ALLIANCE MACHINE COMPANY

Main Office • Alliance, Ohio Branch Office • Miami, Florida

"GIVE US THE RUNWAY AND WE'LL LIFT THE WORLD"

Soaking Pit Cranes

Alliance

Photo Courtesy Lukens Steel Company, Coatesville, Penna.

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB & BILLET CHARGING MACHINES
OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION • COKE PUSHERS • LOADING AND UNLOADING TOWERS

Red Circle Rolls

for all purposes

The Red Circle on the Roll is the Hyde Park mark of Quality. Hyde Park makes rolls for every type mill.

CHILLED ROLLS · ALLOY IRON ROLLS · MOLY ROLLS · NICKEL CHILLED ROLLS · GRAIN ROLLS · COLD ROLLS · SAND ROLLS

for
Finer Finish, Longer Life
and Greater Tonnage
specify Red Circle

Hyde Park
FOUNDRY & MACHINE CO.
Hyde Park, Westmoreland Co., Pa.
ROLLS
ROLLING MILL MACHINERY
GRAY IRON CASTINGS

(*Continued from page 186*)

scale breaking pinch rolls, five 68-in. four-high hot mill finishing stands, two hot strip downcoilers with double coil transfers, descaling systems and lubrication systems.

The four-high universal roughing mill will be automatically controlled by the first overseas application of the "PRODAC" System by Westinghouse Electric Corp. This system will enable the mill to perform a complete rolling schedule according to information stored in a single prepunched IBM card. Any rolling schedule up to nine passes may be preselected, with screwdown adjustments for the horizontal and edger rolls, and mill reversals, automatically controlled.

During each pass, the opening between horizontal rolls will be held within 0.020 in. of the scheduled value stored in the card, and the opening between the edger rolls controlled within 0.100 in. When desired, the controls can be set for conventional manual operation. Main drive for the mill will be designed for 6000 hp, with the edger drive rated at 1100 hp.

When completed in 1959, the new mill will be capable of rolling hot carbon steel strip 0.063 to 0.236 in. thick at delivery speeds up to 2200 fpm.

Mesta Machine Co. is responsible for the design and manufacture of the mechanical equipment, and will provide supervision during installation.

FIRM ANNOUNCES CHANGE OF NAME AND ADDRESS

△ Mannesmann-Meer Engineering & Construction Co., Inc., of Easton, Pa., have moved their operating quarters to Youngstown, Ohio.

At the same time a change in company name to Mannesmann-Meer Inc., and of the move of the president's office to the Canada House, 680 Fifth Avenue, New York 19, N. Y., was announced.

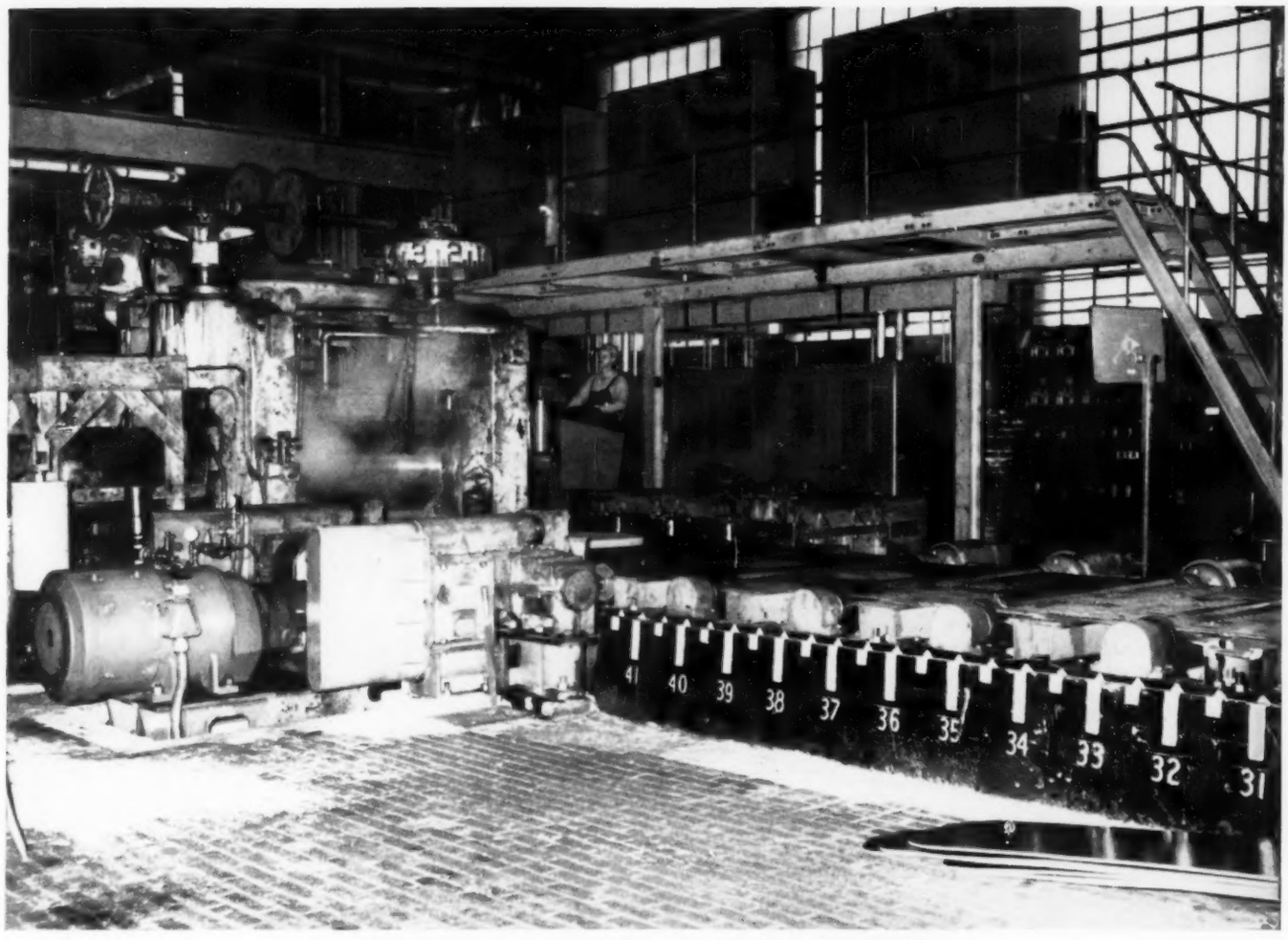
The new company offices will be at 755 Wick Avenue, Youngstown, Ohio.

Meetings

△ The Galvanizers Committee of the steel industry, which is sponsored by the American Zinc Institute, will hold its thirty-ninth meeting on November 6–7, 1958, at the Roosevelt Hotel, Pittsburgh, Pa. This Committee consists of technical and operating representatives of those major steel producers in the United States and Canada who are also engaged in galvanizing sheet or pipe.

NEW METALLURGICAL BUILDING FOR DUQUESNE

This 25,000-sq ft air-conditioned metallurgical building recently completed at United States Steel Corp.'s Duquesne Works houses the process control, control laboratory, inspection, and research and development units of the plant. It is composed of a two-story office and laboratory wing and a single story machine shop, heat-treating and testing laboratory. The building consolidates essential facilities for specification tests, quality control and miscellaneous investigation necessary in the production of quality steel.



Packaged M-G sets and controls are located right at the hot mill in Revere Copper and Brass, Incorporated's New Bedford, Mass. plant

Reliance Packaged Drives cut Modernization Cost 20%

Instead of one large motor-generator set, Revere Copper and Brass, Incorporated used five packaged V★S Drives to power the edger and tables on their rebuilt hot mill.

Reliance Drives package the M-G sets with controls and put them right at the mill itself. Conduit runs are of minimum length, which reduced not only material costs but construction time.

Control installation was vastly simplified. Each V★S Unit was prewired and pretested before shipping. The complete V★S Cabinets had only to be set in place and connected. Extra construction was not required for a generator room.

Packaged V★S Drives cut costs for Revere and gave more flexibility of operation and greater ease of maintenance. Reliance Packaged Drives will reduce drive installation and operating costs for any type of mill.

For complete details contact your Reliance representative, or write today for Bulletin No. D-2506. L-1586

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 1110A CLEVELAND 17, OHIO
CANADIAN DIVISION: TORONTO, ONTARIO
Sales Offices and Distributors in principal cities

America's

Best Known

LADLES..

designed

and

fabricated by

PECOR

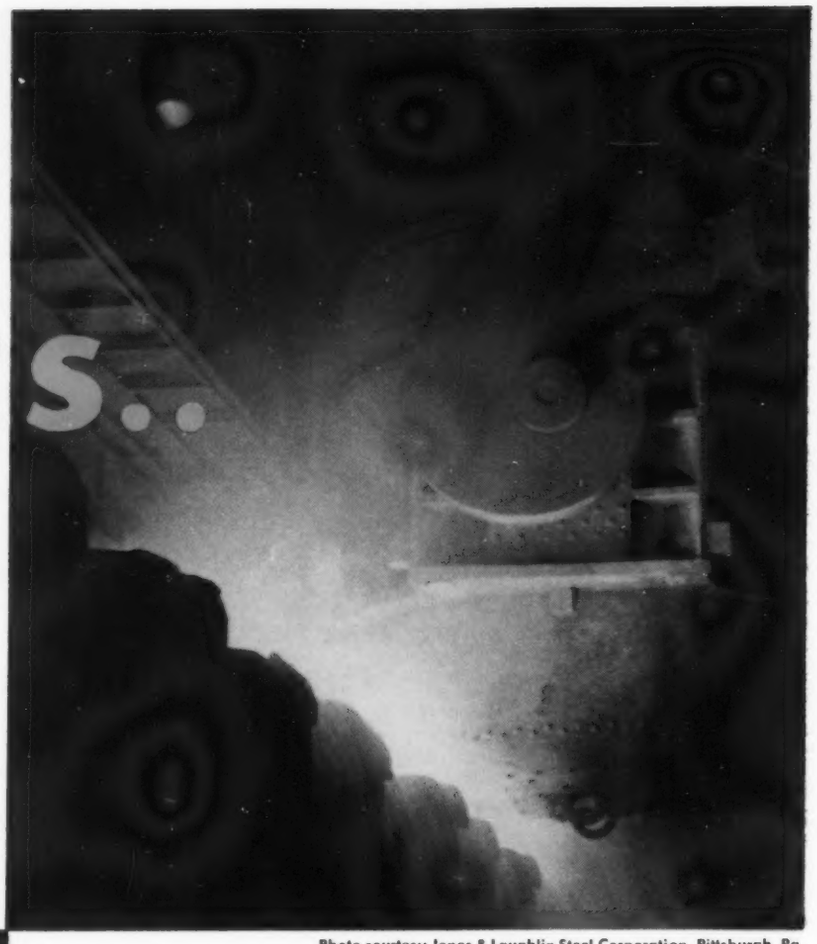
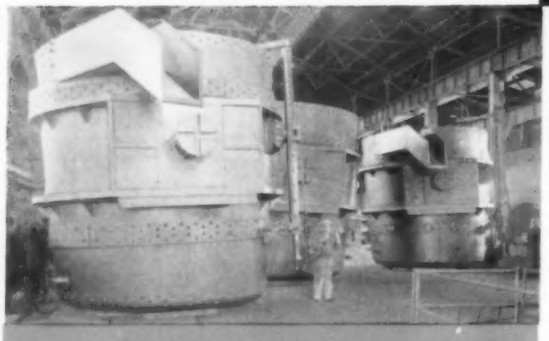
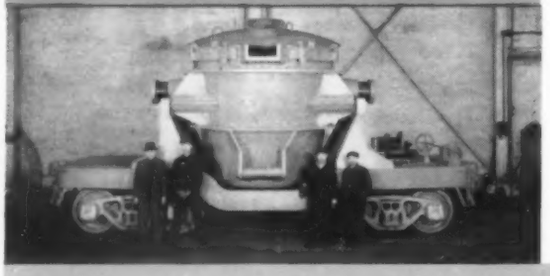


Photo courtesy Jones & Laughlin Steel Corporation, Pittsburgh, Pa.



The superior strength of PECor ladles permits many customers heavy overloads without danger, and capacities are often increased with inexpensive extension of top or bottom shell sections.



Elimination of horizontal shell plate welds adds strength and service life

Hundreds of PECor ladles—many designed and fabricated to individual specs—are in use daily in steel and other metal producing plants across the country. These range in size from 5-ton "midgets" to the largest used today. They represent many original and sound advances by PECor engineers.

Without obligation, we will be glad to consult with you about a PECor ladle built to your exact needs.

Ask about our new special design *light weight* ladles.

WRITE for complete PECor catalog.

PECOR

PENNSYLVANIA ENGINEERING CORPORATION

NEW CASTLE, PENNA.

OTHER STEEL PLANT EQUIPMENT WE BUILD

Blast Furnaces . . . Open Hearth Furnaces . . . Hot Metal Mixers . . . Hot Metal Mixer Cars . . . Ladles . . . Ladle Transfer Cars . . . Scrap Cars . . . Slag Cars . . . Ore Transfer Cars . . . Thermo Metal (Bottle) Cars . . . Jack Cars . . . Ingot Cars

ENGINEERS • FABRICATORS

"AM I GOING HOME?"

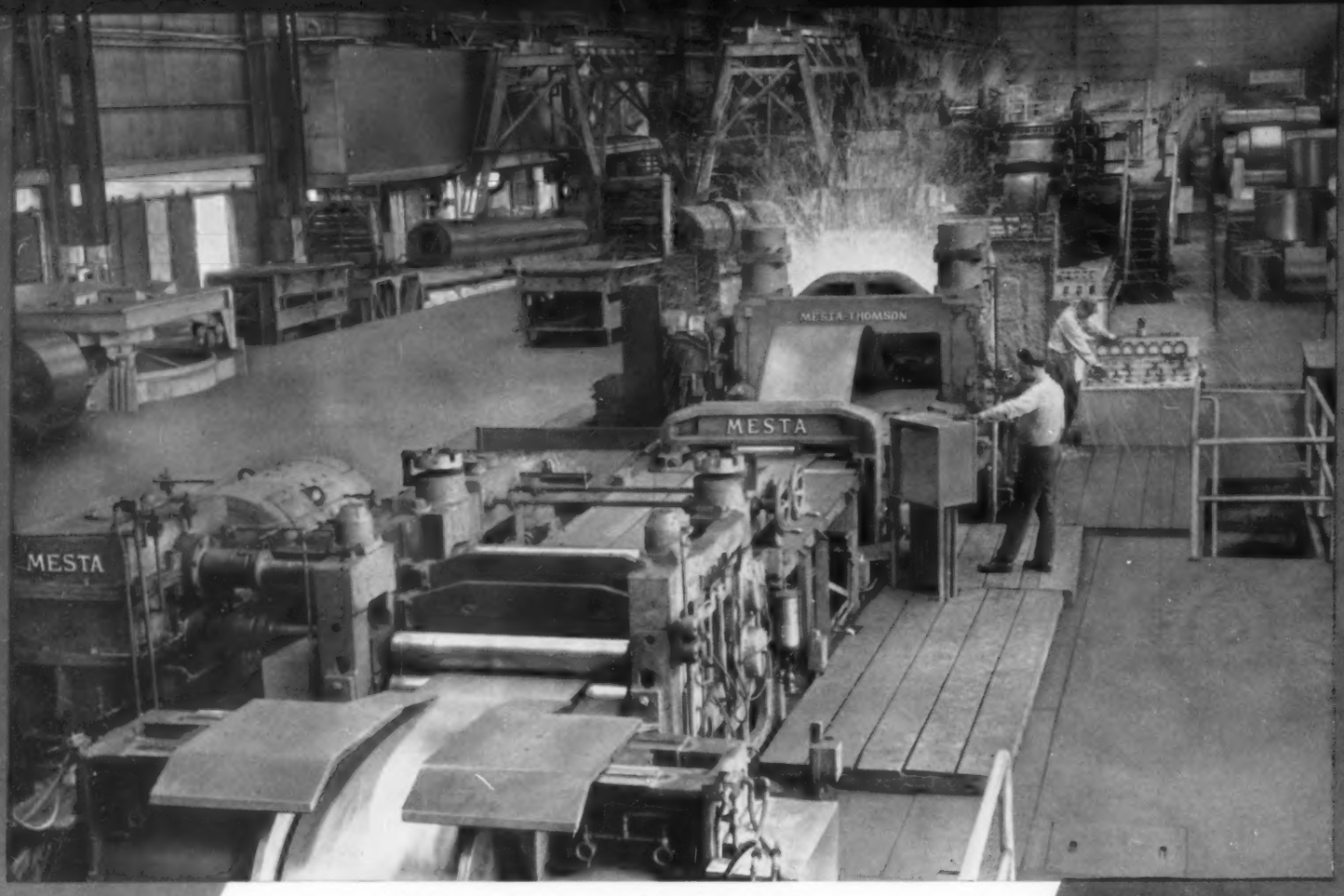
This is an actual photograph of a boy with pulmonary tuberculosis.

Years ago he might *not* have gone home, ever! But thanks to today's modern methods, his case was diagnosed early—and after only a few months of treatment, he was released from the hospital.

Your purchase of Christmas Seals helps to make true stories like this possible—through continually improved TB *diagnosis*, *research*, and *patient rehabilitation*. Send your contribution today, please. ***Buy and use Christmas Seals.***

This space contributed to the National Tuberculosis Association and its affiliates by

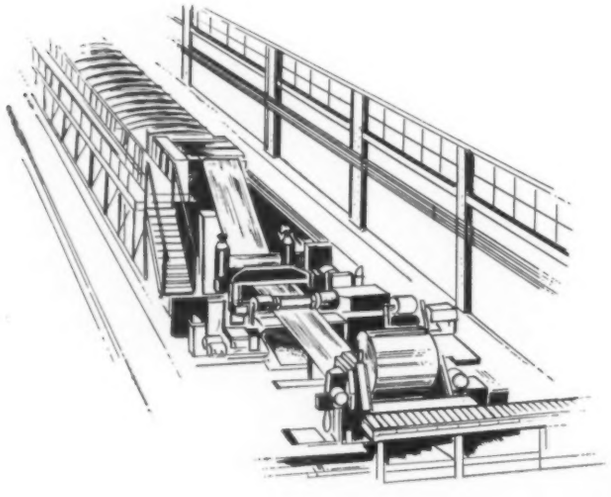
IRON AND STEEL ENGINEER



MESTA 48" Continuous Pickling Line with Primary and Secondary Processors, Flash Welder, Up-Cut Shears, Side Trimmer and Up-Coiler.

Continuous PICKLING LINES

DESIGNED AND BUILT BY MESTA



Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

Personnel News...

William P. Hill was elected vice president—engineering of National Steel Corp., to succeed **Clarence J. Klein,** who retired August 31. Mr. Hill comes to National Steel from Bethelehem Steel Co. in which he has had a career of more than 25 years in various engineering capacities.

Mr. Hill became associated with Bethlehem Steel in 1933. His first position in the mechanical department was followed by experience in maintenance and operations in a number of other departments of the Sparrows Point, Md., plant. In 1935 he was appointed test engineer; was placed in charge of all power facilities in 1939, and in 1942 advanced to assistant superintendent of the general mechanical department of the Sparrows Point plant. In 1945 he was given the assignment of organizing and heading up the initial operations of the construction department. As chief engineer, Mr. Hill was in charge of major construction programs that were conducted during the next several years and in 1950 was advanced to the position of assistant general manager at Sparrows Point. In 1953 he was transferred to Bethlehem, Pa., where he remained until the present as assistant to the vice president—operations. In this capacity Mr. Hill has had charge of engineering programs in all operations of the company.

Clemens A. Tarter has been appointed superintendent of the tin mill at the Kaiser Steel plant, Fontana, Calif. Formerly assistant superintendent, Mr. Tarter succeeded to the post held by **William B. Keirn** who has been named consultant for the tin mill. Mr. Tartar came to Kaiser to head the cold reduction department in the tin mill in 1954, following twenty years experience at various Ohio plants of Republic Steel Corp.

Dr. Hamnett P. Munger, chairman of the Department of Chemical and Metallurgical Engineering at Syracuse University, has been named head of the Metallurgical Division at Republic Steel Corp.'s new Research Center in Independence, Ohio. Dr. Munger, who has been a member of the Syracuse staff since 1955, was assistant chief metallurgist and superintendent of electroplating, respectively, at Republic's Warren, Ohio, steel district from 1936–1944.

Robert P. Hindman, assistant general superintendent of the Butler Works of Armco Steel Corp. has been named general superintendent of the plant. He succeeds **E. T. Mitchell,** who retired October 1. Mr. Hindman joined Armco's Butler Works in 1933. Advancing in the metallurgical department, he became works metallurgist in 1949. He was named assistant to the general superintendent in 1955, and assistant general superintendent in 1957.

Mr. Mitchell has been associated with Armco for 47 years. In 1934, he was transferred to the Butler Works as superintendent of the processing department after holding the same post at Armco's Middletown, Ohio, Works. He was named assistant general superintendent of the Butler Works in 1937 and general superintendent in 1951.

Ralph G. Mehler was named superintendent of the 76-in. and 44-in. hot strip mills of Inland Steel Co. He was formerly superintendent of the galvanizing department. **Edward R. Reed,** former assistant superintendent of the No. 3 Cold Strip Mill, a new mill nearing completion, became superintendent. Named to replace Mr. Mehler as superintendent of the galvanizing department was **John G. Rothfuss,** former assistant superintendent. He is being succeeded as assistant superintendent by **John J. Mulligan,** former general foreman of the galvanizing department.

John C. Ferguson has been appointed director of industrial relations of the Superior Steel Division of Copperweld Steel Co.

Robert W. Allen has been appointed assistant superintendent of Youngstown Sheet and Tube Co.'s Struthers, Ohio, Merchant Mills. For the past six years he has been general foreman of the Strip Mill Roll Shop.

Charles W. Schott has been appointed development engineer, Technical Development at the Crucible Steel Co. of America. He was formerly research metallurgist

W. P. HILL

C. A. TARTER

DR. H. P. MUNGER

R. P. HINDMAN

F. G. GREGORY

E. I. LORENZI

C. W. SHERMAN

FRANK ROSS

with the Research and Development Department. Mr. Schott has been with Crucible since 1954 when he was appointed general supervisor of metallurgical control at the company's Midland, Pa., Works. Two years later he was transferred to the company's general offices in Pittsburgh as staff research metallurgist, a position he held until his present appointment. Before joining Crucible, Mr. Schott was employed by the United States Steel Corp., Carnegie-Illinois Steel Co., and Bethlehem Steel Co.

Frank G. Gregory was appointed assistant superintendent of the Open Hearth Division of Bethlehem Steel Co.'s Lackawanna, N. Y., plant. **Edward I. Lorenzi,** assistant to superintendent of No. 1 Open Hearth Shop, was appointed superintendent of No. 1 Open Hearth to succeed Mr. Gregory.

Charles W. Sherman has been appointed technical director of Jones & Laughlin Steel Corp.'s Stainless and Strip Division. He was formerly senior research associate. Mr. Sherman joined J&L in 1957, after having served as director of research for Latrobe Steel Co. since 1953. From 1950 to 1953, he was process metallurgist and assistant general superintendent, respectively, at Latrobe Steel. Prior to that, he was research assistant at Massachusetts Institute of Technology. Mr. Sherman's association with the steel industry began in 1937 with Armco Steel Corp.

David J. Richards has retired as vice president—sales and director of E. F. Houghton & Co., and two other executives have been promoted. **Frank Ross** was named vice president—sales and **Charles R. Schmitt,** assistant to vice president—sales. Starting as a salesman, he successively became Pittsburgh sales manager, Central Division sales manager, assistant director of sales and a member of the Board of Directors before assuming his most recent position in 1945.

Mr. Ross was formerly assistant to the vice president—sales. He came with Houghton in 1942 as divisional manager of lubrication and became national manager of lubrication sales shortly afterward. In 1949 he was named assistant to the vice president-sales, a position he held until being elected vice president. He was elected to the board of directors in 1957.

Mr. Schmitt joined Houghton in 1942 as lubrication engineer. A year later he was appointed assistant manager of a divisional lubrication department. In 1951, he became national manager of the lubrication sales department, a position he will continue to hold in addition to his new responsibilities.

John P. Strand has been named division superintendent—titanium at Crucible Steel Co. of America's Midland, Pa., Works following the full integration of the company's titanium manufacturing into the plant's operations. Mr. Strand began his career as a contact metallurgist at Bethlehem Steel Co. in Johnstown in 1942. In 1953 he joined Rem-Cru Titanium, Inc., then jointly owned by Crucible and Remington Arms Co. He served in various capacities until he was made superintendent of operations during the earlier part of this year.

J. R. McReynolds has been transferred to the general headquarters of the Youngstown Sheet and Tube Co. as assistant district traffic manager. Mr. McReynolds had been manager of the traffic and purchasing departments, Continental-Emsco Co., a division of Youngstown, since 1956.

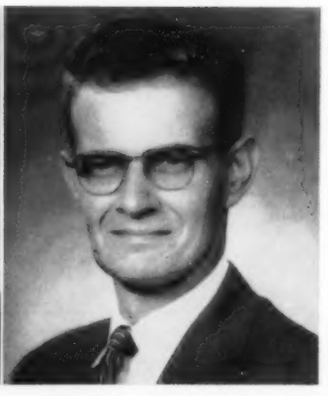
James B. Caldwell, Jr., has been named manager of the San Francisco, Calif., office of the Okonite Co.

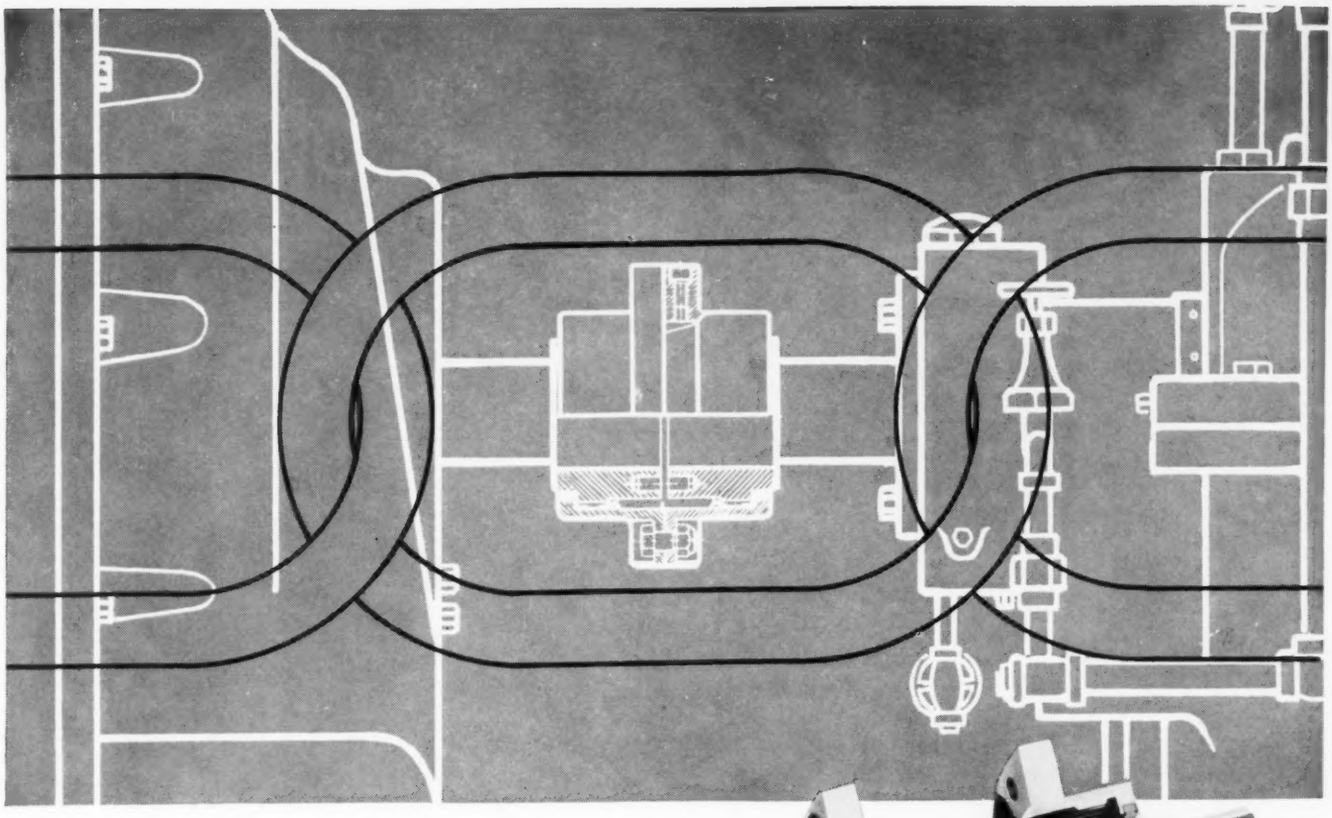
Johan C. H. Larsen was appointed to the position of vice-president, in charge of sales, The Adalet Manufacturing Co. Mr. Larsen has spent the past year serving as the company's assistant sales manager and eleven years as factory sales representative.

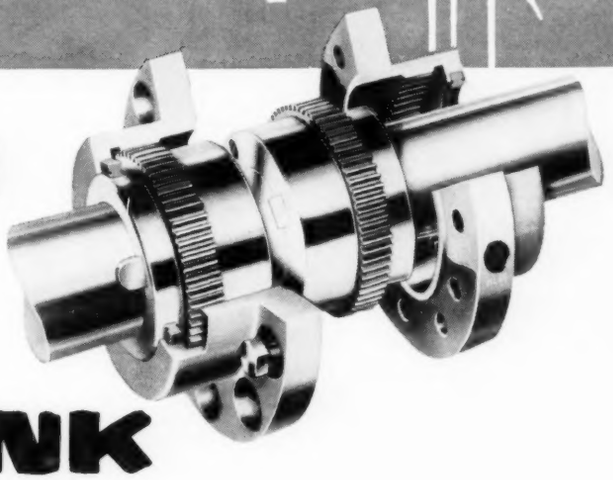
Cecil L. Kerr was named sales representative in the Pittsburgh sales district for Selas Corp. of America. Mr. Kerr comes to Selas from Salem Brosius, Inc., where he

J. C. H. LARSEN

C. L. KERR







FOR WELL-DESIGNED EQUIPMENT...

SPECIFY THIS

POWER LINK

When a lot of time and effort have gone into the design of a piece of driven equipment, it makes sense to pick the power link carefully. Take a pump or compressor, for instance. No matter how well it is designed and built, for long service life and operating efficiency, it needs protection against strains due to misalignment.

Waldron gear couplings provide complete protection and positive, trouble-free drive because

They are strong . . . Hubs and cover sleeves for sizes 1¼A through 7A are machined from tough steel forgings. Hubs are keyed to the shafts. The two one-piece cover sleeves function as a single, rigid unit serving as a floating connecting link between the hubs. High strength of forgings makes possible a very compact coupling with low rotating inertia.

They are reliable . . . There are no flexible parts to bend or break and the coupling is dust, moisture, and oil tight. Patented Walflex seal is at the lowest possible diameter where centrifugal force is least. Clearance between teeth in hubs and sleeve is engineered so that an oil wedge always separates them, taking the wear.

They are available . . . Plenty of rough bore couplings, already assembled—on the shelf for *immediate* delivery. Finish bored standard couplings shipped to meet customers' schedules. We are geared up to give you realistic delivery on *any* type of couplings.

Ask for Catalog 57

JOHN **WALDRON** CORP.

A subsidiary of Midland-Ross Corporation

NEW BRUNSWICK, NEW JERSEY

Representatives In Principal Cities
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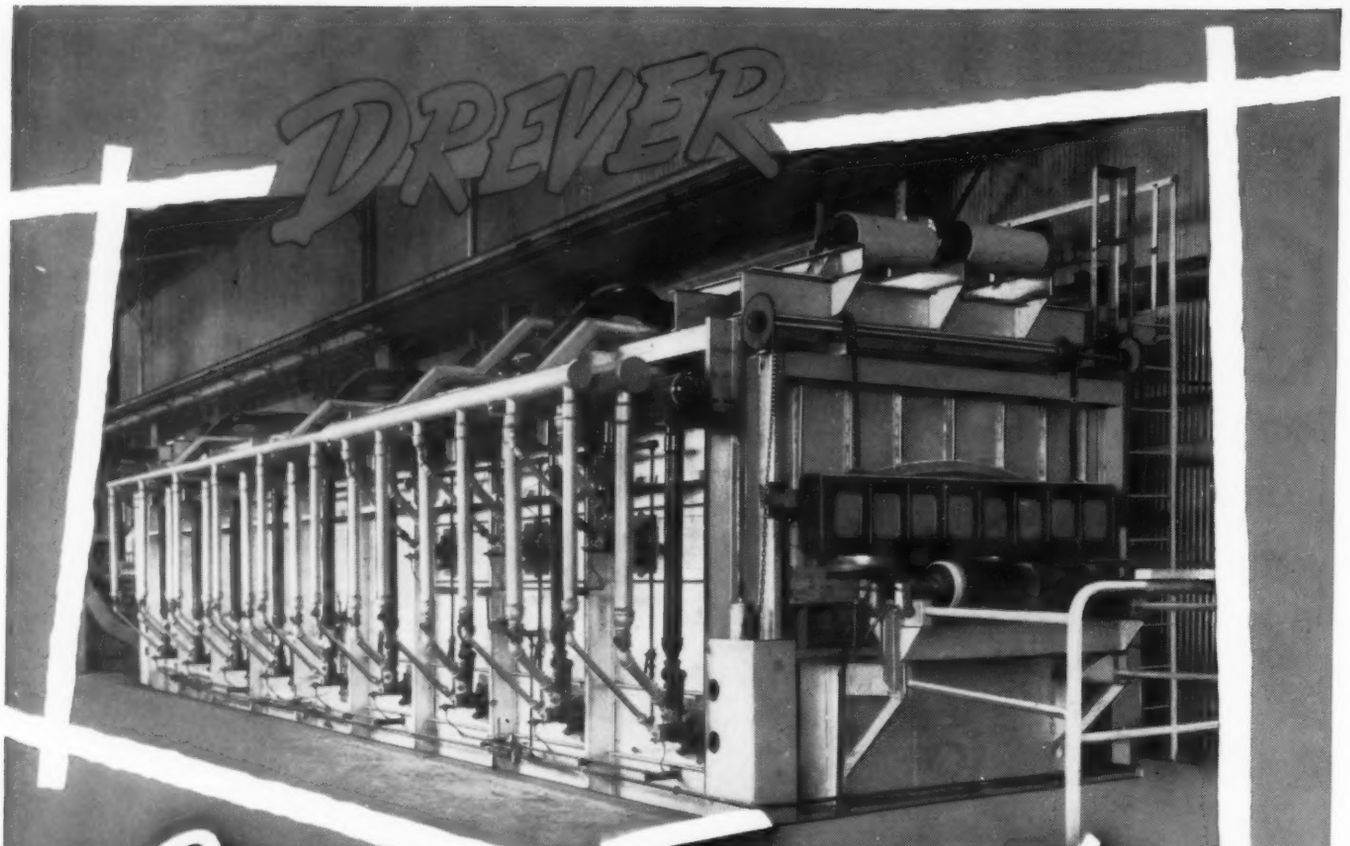


Catenary Furnaces

A 12,000 lbs/hour Fuel-fired Catenary Annealing Furnace for stainless strip used in line with spray quench followed by descaling and pickling baths.

FURNACE CHARACTERISTICS

Inside Dimensions 50'-0" long x 7'-0" wide x 6'-8 3/8" high

Fuel Input ..... 1,800,000 BTU/hour

Operating Temperature Range . . 1200 to 2250°F

Stainless Strip . . . . . Cold reduced—annealed in gauges from 0.007" to 0.125"

Stainless Strip . . . . . Hot rolled—annealed in gauges from 0.093" to 0.200"

Three (3) zone proportioning control

Complete control over fuel-air ratio to maintain desired atmosphere in furnace

DREVER COMPANY

RED LION RD. & PHILMONT AVE., BETHAYRES, PA.

23

held the position of chief engineer—furnaces. He has been associated with Wheeling Steel Corp., Weirton Steel Co., Universal Cyclops Steel Co., Follansbee Steel Corp. and Newton Steel Co., in various operating positions.

William W. Henderson has been elected vice president—sales of Robinson Ventilating Co. Mr. Henderson has been with the company for six years in a sales and engineering capacity.

Earl L. Wilson, Jr., has been appointed manager of the eastern district, Metal Products Division, Koppers Co., Inc. Prior to his latest promotion, Mr. Wilson was sales manager of Koppers Box Machinery Department at Glenarm, Md.

M. Bruce Mairs has been appointed product manager of the newly created Minerals Dressing Department, Mining and Construction Division, of Joy Manufacturing Co. Mr. Mairs had served for the past two years as district manager, Montreal Branch of Joy Manufacturing Co. (Canada) Ltd. He has also served as branch manager of Vancouver branch, and as salesman in various Canadian territories.

J. Dan Malone has been appointed general sales manager of the Enterprise Co. Mr. Malone was formerly with the H. B. Smith Machine Co. as chief executive. He has also been a consulting engineer.

William J. Ryan has been appointed to the position of assistant general manager of the Cleveland Crane & Engineering Co. He formerly was plant superintendent. He has also been elected assistant secretary. **Ralph K. Ford**, who has been Michigan district sales manager for the Heavy Machinery Division, has been promoted to plant superintendent.

Henry J. Calnen has been named eastern representative of the Chas. Taylor Sons Co.

Albert C. Whitaker, Jr., has been appointed director of iron ore procurement, Wheeling Steel Corp. Mr. Whitaker began his Wheeling Steel career in 1928 in the Construction Department of the Steubenville, Ohio, plant. He worked at that plant as a hot strip mill recorder, blooming mill recorder, and a clerk in the hot strip mill. In 1935, he was promoted to a supervisory position in the Hot Strip Mill Department at Steubenville. In 1943 he was transferred to the Operations Division in Wheeling with responsibility for looking after the Wheeling Steel coal properties. In 1951 he was elected to the board of directors of Wheeling Steel. He has been assistant director of iron ore procurement since 1955.

Thomas H. Thoresen has been appointed field sales manager for Hannifin Co., a division of Parker-Hannifin Corp. Mr. Thoresen started with Hannifin Co. in 1945 as a production engineer. He completed sales engineer assignments in South Bend, Ind., and Detroit, Mich., and became regional sales manager of the Cleveland area in 1954.

William F. Oswalt has been named general manager of the Direct Current Motor and Generator Department at the Erie, Pa., plant of General Electric Co. Since 1953 Mr. Oswalt has been general manager of the General Purpose Control Department in Bloomington, Ill.

Edgar H. Dix, Jr., assistant director of research for Aluminum Co. of America since 1942, retired September 1.

A. N. Haig has been appointed engineer-in-charge, sales and engineering, of a newly formed accelerator section in the motor and generator department, Allis-Chalmers, Manufacturing Co. He has been associated with Allis-Chalmers since 1948 and has been supervisory engineer, betatron sales and engineering, regulator department, prior to being named to his new post.

E. A. March, former assistant works manager at the Crucible Steel Co. of America's Sanderson-Halcomb Works in Syracuse, N. Y., has been appointed division superintendent-technical services at the company's Midland, Pa., Works. Mr. March joined Crucible in 1946 as metallurgist-mill control at the Sanderson-Halcomb Works. He became foreman of the rolling mill in 1948 and in 1950 metallurgist-melting department. He was named general supervisor of metallurgical control two years later, chief works metallurgist in 1953 and assistant works manager last year.

E. S. Evans has been appointed engineer-in-charge, project section, and **R. E. Ferber,** supervisor, production planning section, Allis-Chalmers Manufacturing Co.'s Steam Turbine Department.

A. A. Milkie has been appointed manager of the Chicago District of the Pangborn Corp. Mr. Milkie has served with Pangborn as a sales engineer in the Chicago district since 1951.

W. W. HENDERSON

E. L. WILSON, JR.

M. B. MAIRS

J. D. MALONE

George M. White has been appointed plant manager of the Pittsburgh plant of Heppenstall Co. Prior to this appointment, he was staff assistant to the works manager of the Wisconsin Steel Div. of the International Harvester Co. where he started in 1946 as a testing engineer. Mr. White started his business career with Jones and Laughlin Steel Corp.

J. R. Lemmon was appointed eastern region manager, Elliott Co., with headquarters in Philadelphia. Mr. Lemmon has been with Elliott since 1921. His first assignment was in Philadelphia; later he was appointed district manager at Baltimore, then Cincinnati, and Washington, D. C. In 1943, he came back to Philadelphia as district manager. Succeeding Mr. Lemmon as district manager of the Philadelphia office is **H. D. Moll.**

Morris Smith and **George A. Schneidler,** formerly heads of industrial engineering at Armco Steel Corp.'s Middletown Works and Middletown fabricating plant, respectively, have been promoted to division industrial engineers of the company's Armco Division. They will devote their attention to industrial engineering matters in all division plants. Both men will be located in the division's Middletown headquarters. Mr. Smith has been works industrial engineer of the Middletown Works since 1948. He was employed at Armco's Middletown plant in 1935. He became a senior time study man in 1944 and was named assistant works industrial engineer in 1946. Mr. Schneidler joined the engineering department of Armco's Middletown Works, and in 1942, he began time study work. He was named plant supervisor of industrial engineering in 1950 and was advanced to staff assistant to the plant manager in 1957.

Chester F. Wendt has been appointed works industrial engineer of Armco Steel Corp.'s Middletown Works. Mr. Wendt joined Armco at the Middletown plant in 1936 as a laborer. The following year he was transferred to the scheduling department where he held a number of responsible positions. In 1941, he joined the industrial engineering department at the plant and in 1943 became an industrial engineer. He was promoted to methods engineer in 1945, and assistant works industrial engineer in 1947.

John F. S. Abbott has been appointed director of research and development of Rockbestos Products Corp. Mr. Abbott, who joins Rockbestos, had been development project manager for Kaiser Aluminum and Chemical Corp. in Bristol, R. I. Before going with Kaiser, he was chief chemist and chief of latex engineering with the United States Rubber Co.

Louis H. Winkler, metallurgical engineer with Bethlehem Steel Co., retired September 30. He became associated with Cambria Steel Co., at Johnstown, Pa., in 1909, remaining with Cambria through its consolidation with Midvale Steel and Ordnance Co. and its later acquisition, in 1923, by Bethlehem Steel.

Hardie W. Beck has been appointed general manager of the Pittsburgh, Pa., plant of Joseph T. Ryerson & Son, Inc., to succeed **Arthur L. Petersen** who is retiring after 45 years of service. Mr. Beck joined the company at its Pittsburgh plant in 1945. He became manager of the inside sales department in 1947, and in 1956 was appointed a sales representative. He was named sales manager a year later. Mr. Petersen began his long career with the company in 1913. He served in the sales department at the firm's Chicago, Ill., and Detroit, Mich., plants before moving to St. Louis, Mo., as assistant plant manager in 1936. He was named St. Louis plant manager in 1938, and Pittsburgh plant manager in 1949.

L. A. Wells, formerly Elliott Co. district manager in Milwaukee, Wis., has been named Crocker-Wheeler industrial motor sales manager in Chicago, Ill. Mr. Wells was a field engineer in the Chicago district before moving to Milwaukee. **L. E. Rau,** Buffalo, N. Y., district manager since 1951, has been appointed Crocker-Wheeler industrial motor sales manager in New York City. He joined Crocker-Wheeler in 1946. Mr. Rau has been with Elliott since 1949, and he served as field engineer in the Buffalo district before becoming district manager.

Vern R. Billings was named district sales manager of the Midwest Division, Borg Warner Industrial Cranes. Mr. Billings has been actively associated with the materials handling industry for over 18 years.

James E. Partlow has been appointed assistant general sales manager of General Refractories Co. Mr. Partlow was formerly district sales manager for the company in Houston, Tex. In his new position he will co-ordinate the activities of the following managers whose appointments were made simultaneously: **W. H. Boyd,** specialties; **G. L. Peck,** rock products; **W. F. Rappold,** nonferrous, and **R. G. Abbey,** glass and chemical sales. Other appointemnts made by the company are the following: **George C. Mayhew,** district sales manager of the Detroit, Mich., office; **George H. King,** attached to the administrative sales division in Philadelphia, Pa.; **Sumner E. Brumbaugh,** assistant district sales manager of the Pittsburgh, Pa., office; **Edward B. Huffman,** attached to the Chicago, Ill., office; **John F. Small,** assistant district sales manager of the St. Louis, Mo., office, and **Leonard D. Borter,** attached to the Pittsburgh office.

Obituaries

Stewart J. Cort, retired vice president of Bethlehem Steel Co.'s steel division, died September 23. He was 77. His contribution to the steel industry covers over 50

STEWART J. CORT

years, 40 of them in the employ of Bethlehem. During his ten years as vice president, the company completed the largest expansion program of its history, adding over 10 million tons to its annual ingot capacity.

The Cake that Dwight and Lloyd baked, and patented. *Only a pallet full of sinter, but easily*

WORTH ITS WEIGHT IN GOLD

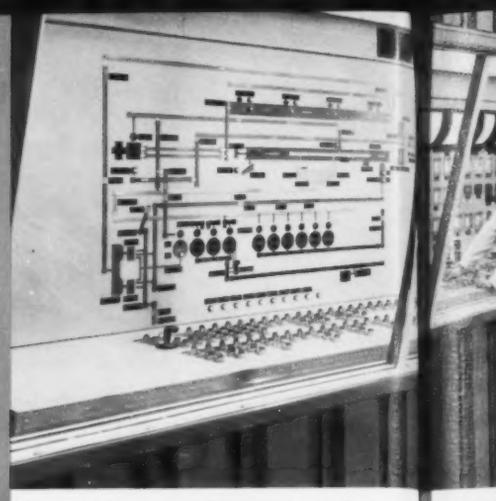
Historical dates in Continuous Sintering

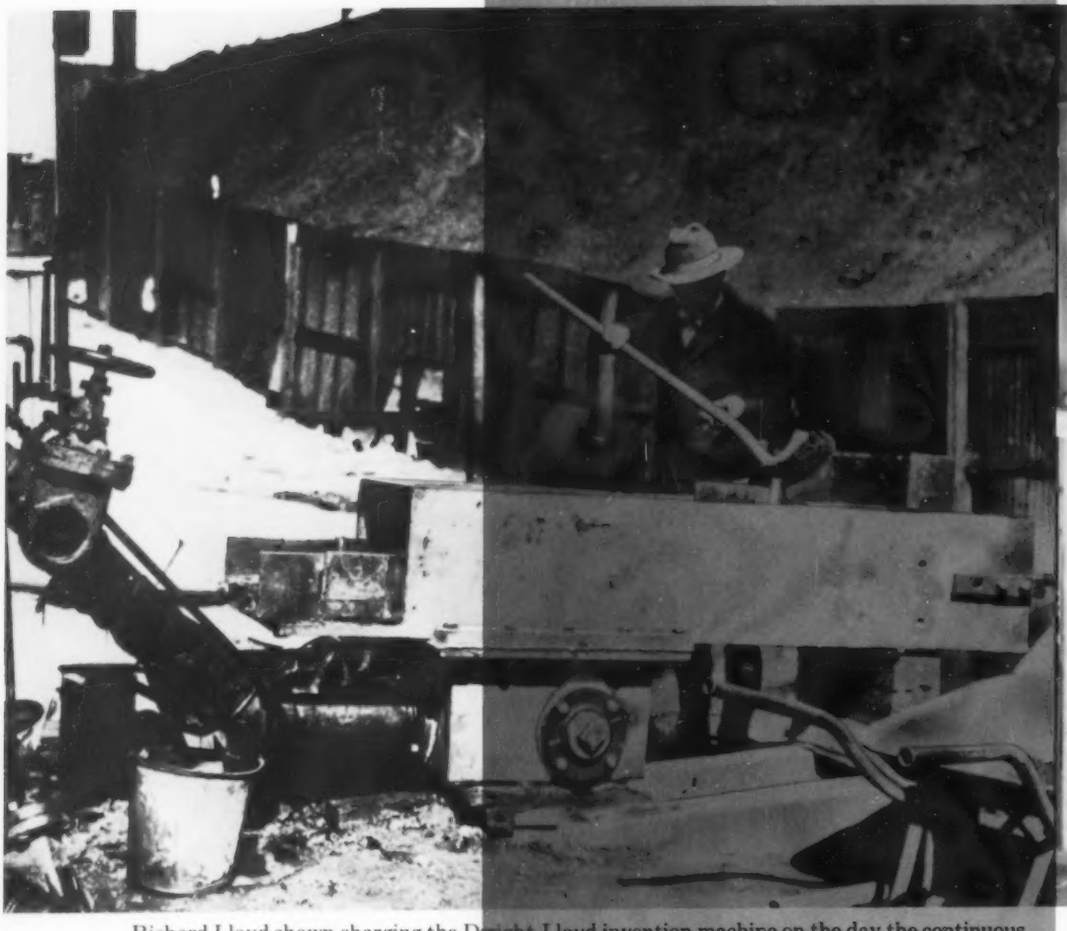
1906 The continuous sintering process was invented by Arthur S. Dwight and Richard L. Lloyd following extensive experiments at the Greene Consolidated Smelter in Cananea, Mexico. Patent was applied for.

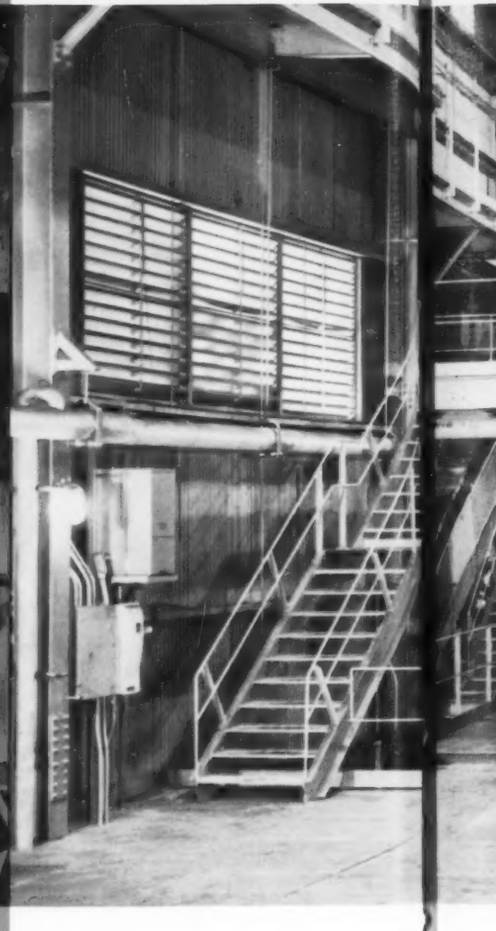
1908 The first patents on the process were granted.

1908 Dwight and Lloyd applied for a patent on the product – a cake of sinter – which was granted.

1908 The first commercially successful continuous sintering plant was installed at Salida, Colorado at a multi-metals smelter. It marked the establishment of the "straight line" or classic machine, the design that endures to this day.







Richard Lloyd shown charging the Dwight-Lloyd invention machine on the day the continuous sintering process was born. An original photo, preserved in the Dwight-Lloyd historical archives.

1908 Dwight began his first investigations of a sintered beneficiated blast furnace charge for ferrous industries.

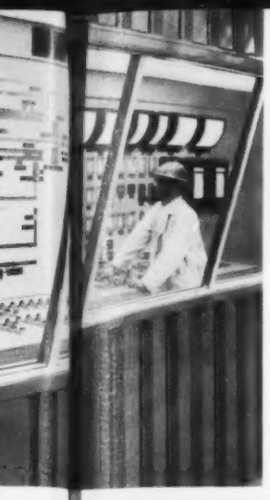
1909 Dwight and Lloyd granted a license to Lurgi-Gesellschaft to build sintering equipment under the Dwight-Lloyd patents.

1911 The first ferrous sintering plant was installed at Birdsboro, Pennsylvania. The plant was designed by Dwight and Lloyd and delivered by a licensee, American Ore Reclamation Company.

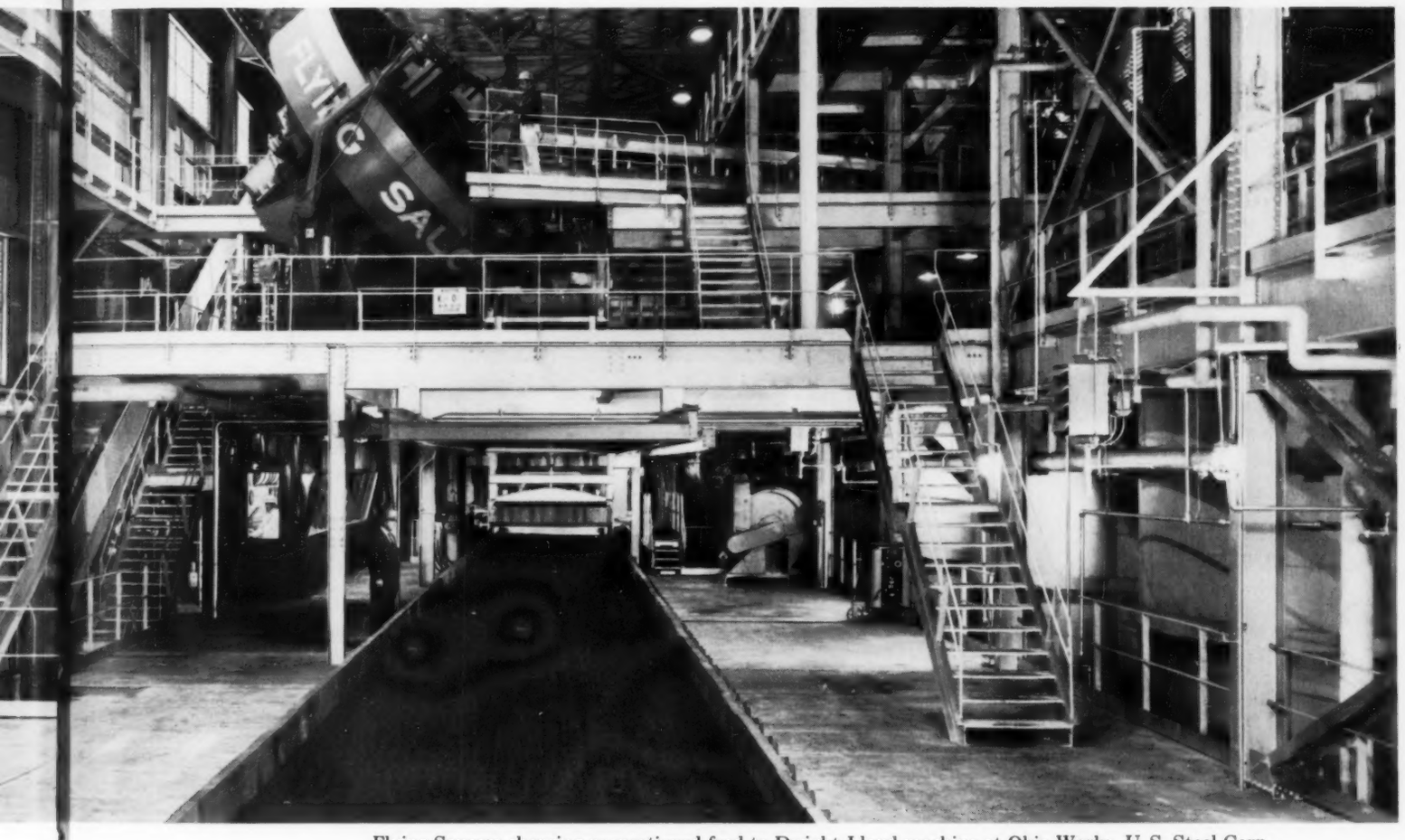
1920 The Dwight-Lloyd Research Laboratories were established to fully investigate minerals processes.

1955 McDowell Company, Inc. acquired the business and assets of Dwight and Lloyd, including the Laboratories, and moved them to Cleveland, greatly expanded.

Now



Left, automated control center for new 5,000 ton per day single strand ferrous Dwight-Lloyd* sintering plant. Above, general view of plant. Right, the McDowell-developed Flying Saucer*, unsurpassed as a sinter mixing and pelletizing disc.



Flying Saucers charging proportioned feed to Dwight-Lloyd machine at Ohio Works, U.S. Steel Corp.

DWIGHT-LLOYD SHOWS SINTERING'S GOLDEN ERA

Big production ferrous installations are the newest Dwight-Lloyd sintering plants, developed to increase capacities of high-investment blast furnaces through beneficiation of raw materials. This acknowledges the work of our illustrious ancestors, the American metallurgists Dwight and Lloyd, who invented and pioneered continuous sintering, and proved to Illinois Steel Co. in 1908 the economical merit of sinter as blast furnace feed.

Culminating fifty years' practice, today's rugged Dwight-Lloyd plants reflect advanced McDowell engineering *and U.S. tonnage experience* in 1) proportioning and blending, 2) ignition, 3) burning and 4) cooling – all pilot-plant-proved in our famous Dwight-Lloyd Research Laboratories, established by the inventors in 1920, busy ever since on behalf of an international clientele engaged in all phases of minerals processing. Exclusive: Wellman hell-for-stout fabrication.

Dwight-Lloyd Division, McDowell Company Inc. • Cleveland 10, Ohio, U.S.A.

PEOPLE & U.S. ENGINEERING & RESEARCH

Key Dwight-Lloyd® personnel, at left, photographed in the Lab. *Counterclockwise from left:*

ROBERT C. McDOWELL, *President*, McDowell Company

PATRICK V. GALLAGHER, *Vice President*, McDowell Company

THOMAS E. BAN, *Director of Research*, McDowell Company

CHARLES D. THOMPSON, *Assistant to the Director of Research*

CHARLES A. CZAKO, *Research Metallurgist*

HAROLD E. ROWEN, *General Manager*, Dwight-Lloyd Division

ALLEN R. ROWEN, *Chief Project Engineer*, Dwight-Lloyd Division

experience explains Dwight-Lloyd® leadership in continuous sintering

SERVING a world-wide clientele in a multitude of ferrous and non-ferrous applications, Dwight-Lloyd continuous sintering is the bonanza of today's minerals processing. Our thoroughly American engineering approach delivers custom-tailored pyrometallurgical plants distinguished by the McDowell-developed Flying Saucer®, a superior mixing disc, and our ABCs® Belt Scale.

Conclusive pilot plant work at our famous Dwight-Lloyd Research Laboratories, also founded by the inventors of the continuous sintering process, adds reputation and confidence to Dwight-Lloyd — *the granddaddy of them all and still the best.*

SINTERING AT DWIGHT-LLOYD® DIVISION

McDOWELL COMPANY, INC., CLEVELAND 10, OHIO, U.S.A.

The McDowell Family of Related Enterprises — *McDowell Turnkey Plants • Dwight-Lloyd Research Laboratories Wellman Bulk Materials Handling Systems and Steelmaking Machinery • Anker-Holth Power Cylinders Dwight-Lloyd Ore Beneficiating Plants • ABCs Belt Conveyor Scales • Williams Buckets • Wellman Locomotive Cranes*

Call or Write **STAMCO** for...

Corrugating and Complete Line of Culvert Equipment—Slitting and Coiling Equipment for Ferrous and Non-Ferrous Material in All Capacities—Warehouse and Steel Mill Cut to Length Lines for Shearing and Levelling Sheets from Coils—Shears for Shearing Sheets and Plates Both Underdriven and Overdriven Types in all Capacities up to 1¼" plate.

STAMCO, Inc., New Bremen, Ohio

The overwhelming majority of cranes and pulpits being equipped with air conditioning are Lintern equipped.

The reasons for this are contained in our 20-page Bulletin AC-573 which describes Aire-Rectifiers for each temperature range of cab, also models for pulpits.

Write for copy today.

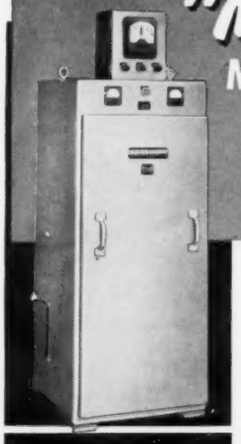
Larco, inc.

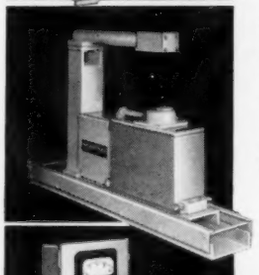
DISTRIBUTOR OF LINTERN CORPORATION PRODUCTS

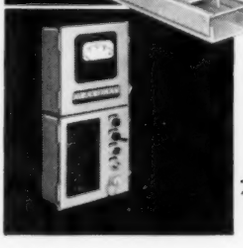
ROUTE 20, EAST • PAINESVILLE, OHIO

"MEASURAY"

MEASURES THICKNESS ACCURATELY *without TOUCHING the MATERIAL*







Hot or Cold Strip Steel, Brass, Copper, Aluminum . . . Plastics, Foils, Coated Fabrics, Film, Rubber, Etc., Even When Moving At High Speed.

Simple method—the "Measuray" shoots X-Rays through the material—measures its absorption of the rays. Calibrated meter registers plus or minus per cent of deviation from pre-determined standard. Especially useful on hot mills where material can't be checked by contact gages. Also when material can be deformed by contact such as foil.

"Measuray" is accurate to 1% of thickness or less. Quickly pays for itself in reduced scrap.

Write Today for Literature to Dept. 25, ***The Sheffield Corporation,*** *Dayton 1, Ohio*

the **SHEFFIELD** *corporation*

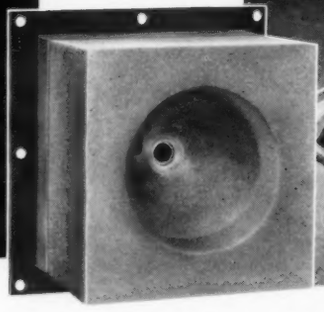
of Bendix Aviation

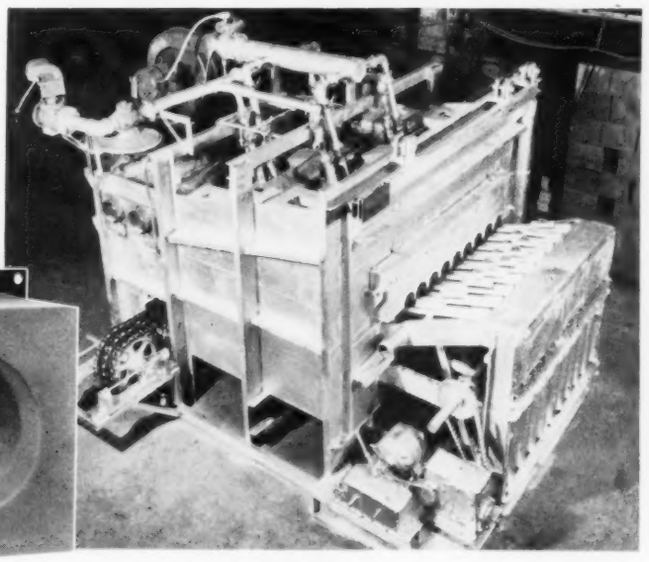
manufacture and measurement for mankind

Mr. Forge Supt.—

New High Thermal Release "Scaling Virtually Eliminated"

with HAUCK Hi-Radiant Cone Gas Burners





Forge heating output raised 44% above estimate

This pusher type forging furnace, built by J. A. Kozma Company and designed to heat 2500# of steel per hour to 2250°F. with 4 million Btu/hr. input, has actually been heating 3600#/hr. with the same heat input—44% above expected capacity. Heating rate is now equal to 135# per sq. ft. of hearth area.

The furnace is roof-fired by Hauck Series RCG "Hi-Radiant" Cone Gas Burners, without flame impingement on the forgings. High speed combustion, with short flame length and low forward velocity of combustion gases, permit placement of the burner cones closer to the work, with resultant intense heat radiation and uniform heat absorption. Scaling has been practically eliminated. Turndown ratio is 10 to 1.

All this adds up to more output in a smaller furnace with less fuel and less maintenance of burners.

Whether for high speed heating—even to 2900°F.—or low temperature processing. "Hi-Radiant" Cone Gas Burners on your furnaces can spell definite economies in installation and production cost.

Let Data Sheet 809 help you evaluate what these Series RCG Burners can do for your heating operations.

HAUCK MANUFACTURING CO.

114-124 Tenth Street, Brooklyn 15, N. Y.

TRABON

CENTRALIZED LUBRICATING SYSTEMS

Make more profit per stamping with Trabon

Stop a press due to lack of lubrication and your cost per stamping soars! Add up the man hours it takes to lubricate a press by hand and it will stagger you. Yet, each time your press is down because of these reasons, you are losing money.

That's why manufacturers and operators install Trabon on their presses. A Trabon Centralized Lubricating System delivers the **exact** amount of oil or grease to bearings wherever located. Trabon does this automatically or manually, for hydraulic, mechanical, electric motorized and pneumatic equipment. In this way, Trabon protects expensive bearings, eliminates downtime due to haphazard lubrication, saves lubricant. Be sure to install Trabon on your equipment — soon! You'll reap the benefits immediately!

Trabon

Trabon Engineering Corporation

28785 Aurora Road • Solon, Ohio

Centralized OIL AND GREASE SYSTEMS *Mistyfog* CIRCULATING OIL SYSTEMS

"Whitened" Trabon pumps and feeder valves provide these Verson eccentric presses with the exact amount of lubricant needed. Note the centralized warning-light system facing the operator, a standard Trabon feature.

Equipment News...

CRANE SYSTEM

Δ A new current collecting system for cranes and other electrified machines has been introduced by The Pittsburgh Carbon Div. of Ringsdorff Carbon Corp. This system, used for over 40 years in Europe has many advantages. It utilizes carbon sliding contacts on its copper head steel conductor rails. This method was adapted because: (1) copper is an excellent conductor, (2) the wear of the copper conductor is negligible due to the lubricating action of the carbon contacts and (3) the wear of the carbon contacts is practically nil for the same reason. The Stemmann current collecting system consists of three major components. They are the copper head steel rails as conductors, the pantographs with their carbon shoes as collectors, and, special high strength Steatite insulators for electrical insulation.

The carbon contacts provide the copper rails with a protective coating as well as a cleansing action. As a result, this system is impervious to atmospheric conditions.

The pantographs, with their complete action-free, spring loaded scissor construction are more flexible than ordinary rigid contacts. The pantograph can tolerate a great deal of misalinement and still keep contact with the rail. They can be designed to take up any amount of play. The insulators are made of a refractory material called Steatite which is electrically the equivalent of porcelain but far stronger structurally. Fastening of the bolt to the Steatite with cement has been eliminated. Instead, a slit bushing is conically expanded within the insulator and welded to the bolt.

The system due to the use of copper on steel, is relatively small, lightweight and does not require any strong supports. Because of the usually very limited space for crane contact lines, the current collectors have been designed as small as possible. The joints of the scissors (twin guide construction) have been arranged in such a way that the contact is kept at a nearly constant pressure in all positions and is directed perpendicularly to the contact lines. The collectors may be positioned vertically in either an under-running or over-running position with respect to the rail or in a horizontal or sideways manner. These current collectors are especially for cranes, electro pulley blocks and suspended railways.

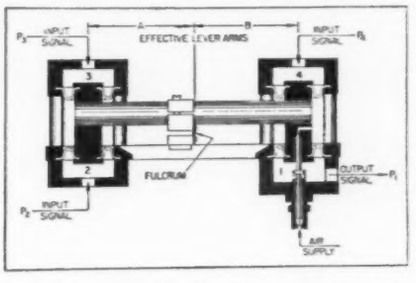
RATIO TOTALIZER

Δ Hagan Chemicals & Controls, Inc., is now offering a new, more sensitive model of their all-purpose controller, the MSP-120 ratio totalizer. This low cost, pneumatic control unit was redesigned to reduce its spring rate for better over-all accuracy, particularly in the 3 to 15 psig range.

Also, a new microlock poppet valve (sending chamber pilot valve) is available as optional equipment. It can be quickly removed, cleaned and remounted in the sending chamber without resetting.

A four-chambered force-balance device, the ratio totalizer accurately combines up to three input signals to produce a single output signal pressure. It is an old standby in the general process industries, boiler control systems, steel, utility, and industrial power stations and testing laboratories.

Weighing just 15 lb and measuring less than 9 in. from end to end, the ratio totalizer functions both as a controller and computer. It can provide proportional, integral and rate actions as well as addition, sub-

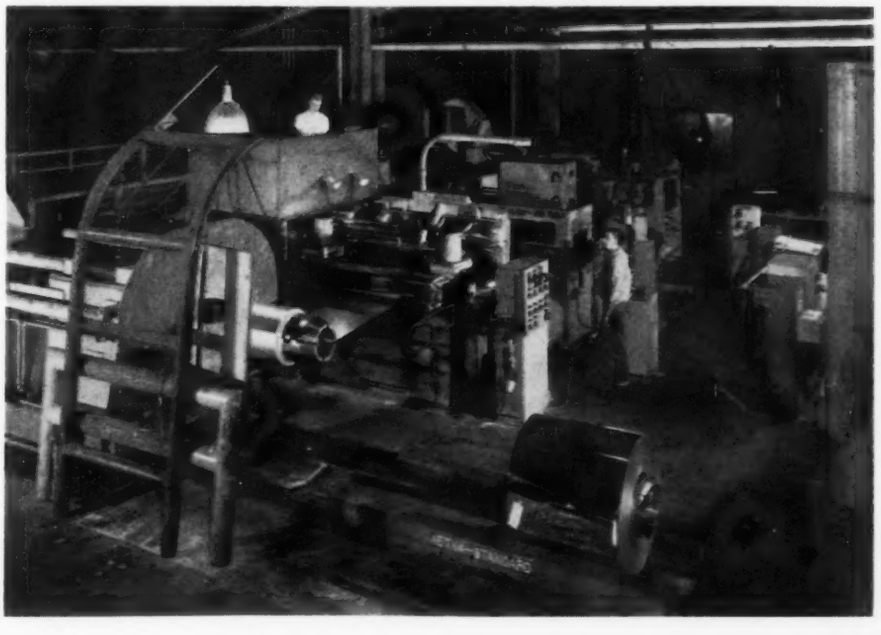


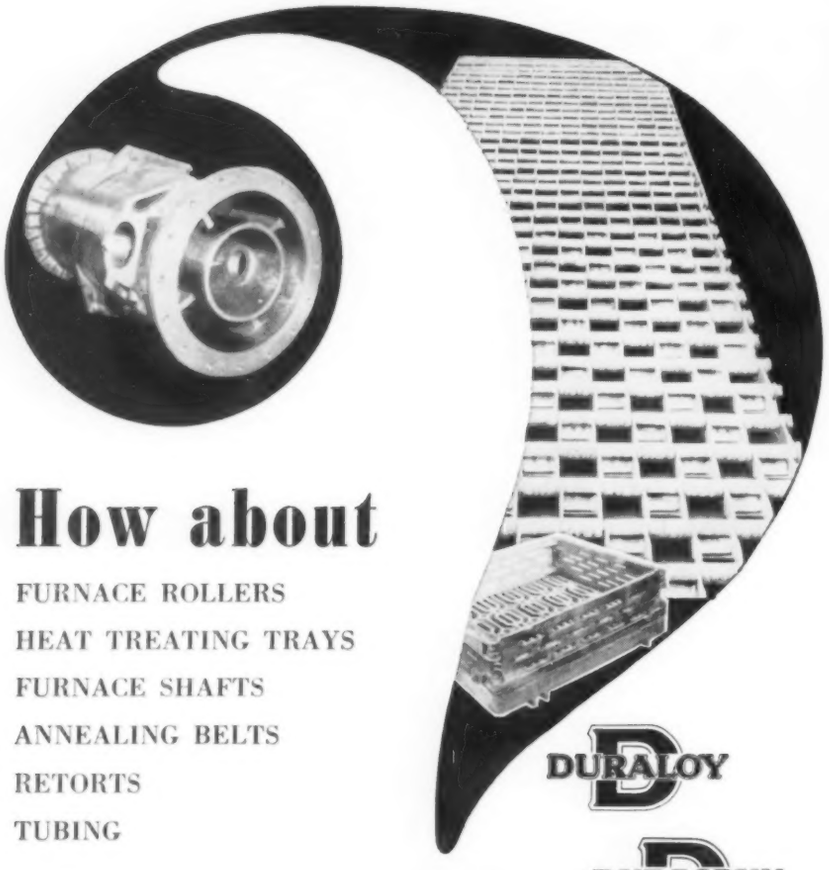
traction, multiplication and ratio functions as required.

Output signals in the 3–15, 0–30 and 0–60 psig ranges are suitable for actuating recording and indicating instruments, or can be used as control signals for other elements in an automatic control system. The unit can be equipped with remote, automatic set point adjustment and used as the master controller in

COIL PREPARATION LINE AT INDIANA HARBOR

Pictured is a 4000-fpm coil preparation line for tin plate. This equipment, designed and built by Aetna Standard Engineering Co., was recently put into operation at The Indiana Harbor Works of the Youngstown Sheet and Tube Co.





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FURNACE ROLLERS
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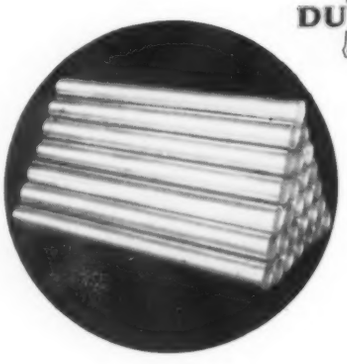

When ready to order, how about checking with us here at DURALOY? For more than thirty years we have specialized in high-alloy castings. In fact, we were among the first to produce static castings and the first to produce centrifugal castings. We are old hands at producing castings alloyed to fit each specific requirement and to finish them to any extent desired.

Melt, castings and finishing are carefully controlled and quality tested by our staff of metallurgists, chemists, X-ray and gamma-ray technicians. If you would like more preliminary information, send for Bulletin No. 3150-G.

The DURALOY Company
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CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

small systems. Interchangeable diaphragm and bellows elements are available for input pressures up to 600 psig. The two types of fulcrums, ball bearing for high shock and vibration services and standard flexible strip type, can be adjusted to change the relation between incoming signals and output signals. This permits the adjustment of proportional band characteristics.

The unit also can be used to accurately measure mechanical forces such as thrust, weight or torque, and to provide a pneumatic signal for use with instruments or control circuits. When used in multiple, a wide variety of combinations can be worked out for over-riding and limiting control actions.

The compact controller has no stuffing boxes or pressure tight bearings and can be bracket-mounted in any position.

MARKING PAINT

△ Phillips Products, Inc., has made available a new marking material that can be placed on bare metal to identify iron and steel sections and which instantly penetrates any subsequent paint coatings. It is called Penapaint.

An identifying code of Penapaint is placed on the metal with a brush,

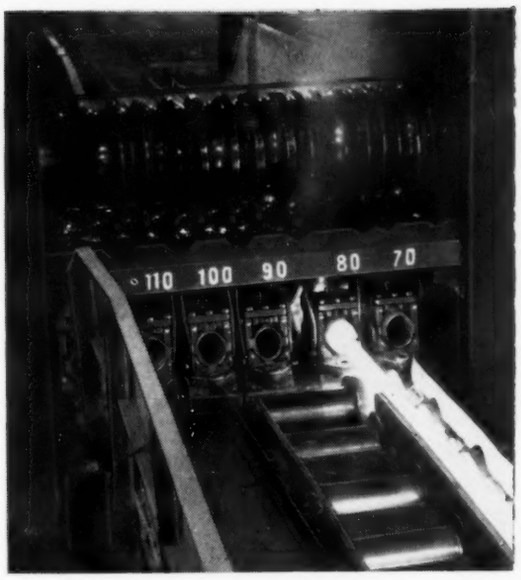
spray or stencil either before or during fabrication. When a protective coating is applied, Penapaint instantly penetrates through this coating. The original code number continues to identify the section after painting and through all subsequent fabricating and assembly operations.

Raw material can be coded and then handled in the most convenient and economical manner. Similar parts for several jobs can be processed at one time with substantial savings in handling and setup time but without confusion as to identity.

A Penapaint code number is not on the paint but in the paint. It

(*Please turn to page 212*)

8 good reasons why you should use these ROLLER GUIDES in your bar or wire rod mill



Nos. 125 and 155 roller guides fitted in a 27 1/2 in. (700 mm.) diameter, three-high stand for rolling 2 3/4, 3 3/16, 3 9/16, 4, 4 3/8 and 4 7/8 in. (70, 80, 90, 100, 110 and 124 mm.).

1 The entry friction guides are rigidly clamped into the guide box. They are intended to lead the oval to the groove in the roller, to protect the rollers against overloading, and to straighten bent rods.
The groove in the entry guides is made about 1/8" wider than the oval.

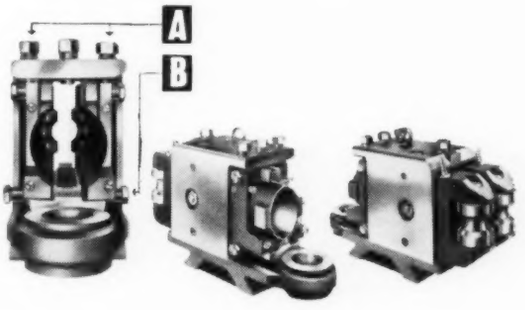
2 The rollers are mounted on leaf springs, which can be adjusted by means of the screws "B", and hold the oval steadily even if there should be some slight variation in the thickness of the oval.

3 If the thickness of the oval should vary, the springs of both rollers yield an equal amount, so that the oval remains in the centre of the groove.

4 To tilt the oval, the screws "A" are adjusted. One roller will then be lifted as much as the other is lowered.

5 As the oval is held very rigidly, the leader oval for wire rod may be thick, unless other circumstances call for a thinner oval.

6 The roller guide assemblies are narrow, and all screws that require adjustment during rolling are accessible from the front of the mill. No lateral space outside the guide box is therefore required for gaining access to the set screws, and the guide box assembly can thus be located close to the mill housing.



7 As the groove in the entry guides is wide and nothing but rolling friction acts on the oval, the latter is very easily introduced into the pass, and there is practically no risk of scratching the bar.

8 The roller guide may be used not only for leader and drawing oval passes but also for edging flats as well as for rolling squares, hexagons, octagons and various other sections, for instance in reduction passes for hexagon. It is suitable for all types of rolling mill. An important advantage is that the roller guide enables repeaters to be used in rolling plump leader-ovals.

PS *Practically speaking, every bar and wire rod mill in Scandinavia uses roller guides of our design.*

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put physical and thermal properties *in proper balance!*

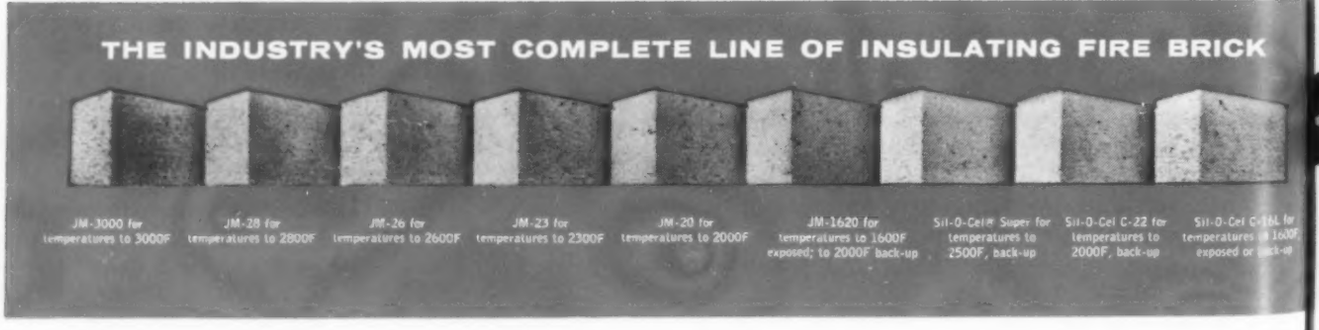
...provide essential high-temperature resistance and low conductivity...yet maintain high load-bearing strength with low spalling!

Only Johns-Manville's insulating fire brick family offers the right combination of properties to meet the diversified requirements of modern furnace construction.

Johns-Manville's nine different insulating fire brick mean you never have to settle for a brick that's nearly right! Instead you choose the one insulating fire brick or combination of brick that best meets your specific requirements for temperature resistance, load-bearing strength, conductivity and density.

Johns-Manville has two strategically located plants for the production of insulating fire brick: Lompoc, California and Zelienople, Pennsylvania. Insulating fire brick and other Refractory Products are available from the stocks of Authorized J-M distributors in key industrial areas.

For further information, call your nearest J-M representative. Or write for brochure IN-115A to Johns-Manville, Box 14, New York 16, N.Y. In Canada, Port Credit, Ontario.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JM-3000 for temperatures to 3000F
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JM-23 for temperatures to 2300F
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JM-1620 for temperatures to 1600F exposed; to 2000F back-up
Sil-O-Cel® Super for temperatures to 2500F, back-up
Sil-O-Cel C-22 for temperatures to 2000F, back-up
Sil-O-Cel C-16L for temperatures to 1600F exposed or back-up

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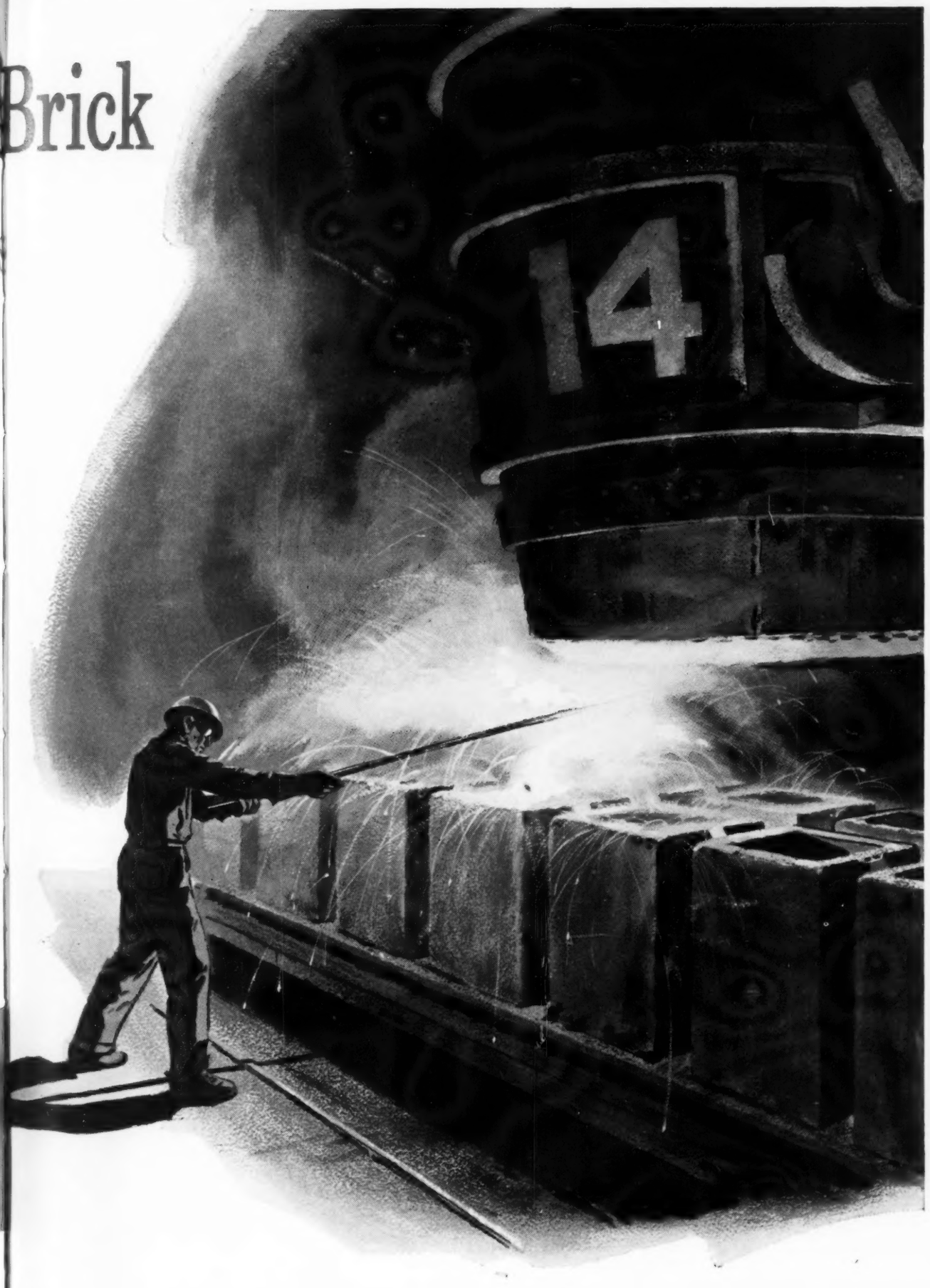
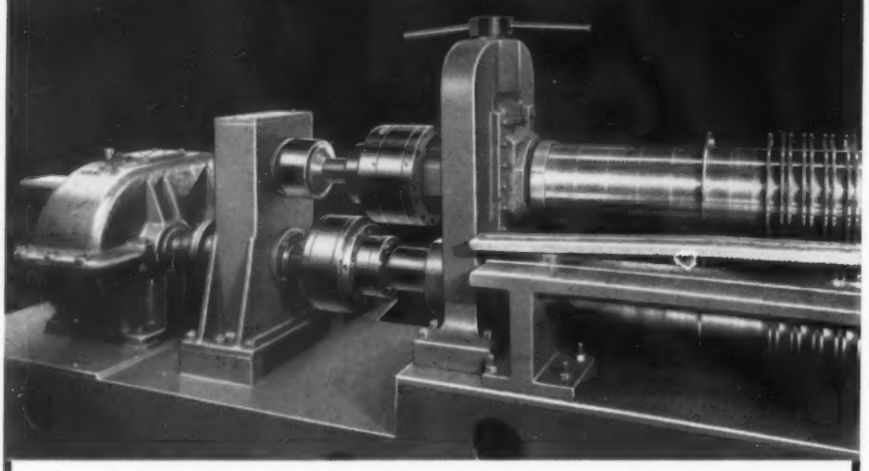
Johns-Manville REFRACTORY and NS



Brick

NSULATING REFRACTORY PRODUCTS

for slitter dependability specify
MARLAND ONE-WAY CLUTCHES



Dependable slitter performance is assured by the full-phased, controlled roller action design of Marland One-Way automatic freewheeling clutches. Full-phased roller action permits positive, instantaneous slitter driving or absolute slitter freewheeling for complete protection to the material being processed. For clutches that will give outstanding service and long life on metal slitting, rolling and drawing applications, refer to Marland One-Way Engineering Manual No. 56.

MARLAND ONE-WAY CLUTCH COMPANY
ELM AND WASHINGTON AVES., LA GRANGE, ILLINOIS

SALI Insulating Bushings
For Electrical Conduit and Boxes

Certainly they cost more!

Why settle for less? The steel mills for twenty-five years have depended on them to safeguard their production life-lines where wires emerge from conduit.

THE Adalet MANUFACTURING COMPANY
14300 LORAIN AVENUE • CLEVELAND 11, OHIO

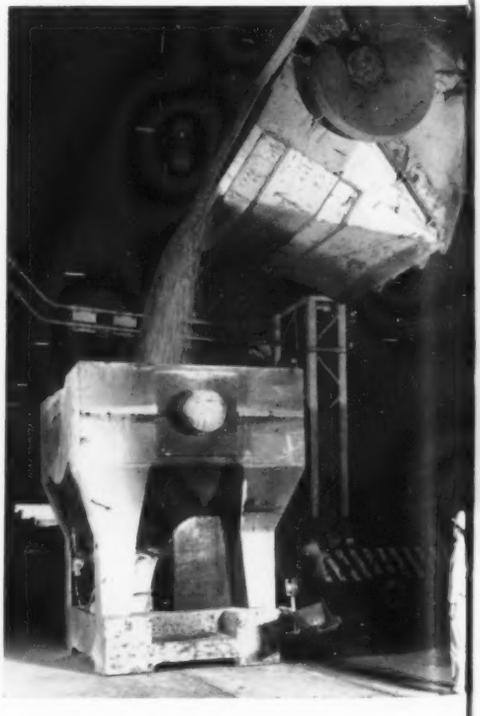
(*Continued from page 208*)

cannot rub off or wash off. It eliminates confusion in shipping; confusion in locating sections at jobsites or assembly points; the need for service records to identify a section during fabrication; and any possibility of error in recording and recopying code numbers of sections. It simplifies cost accounting and minimizes errors in time and fabricating records.

A Penapaint code is on a section, permanently visible, and stays that way through every step of fabrication and assembly until it is no longer needed. When the code has served its purpose, all further penetrating action can be easily and quickly stopped at any stage with Penapaint Mask. This is a specially compounded material through which Penapaint will not penetrate. It is painted over the code number, drys quickly and provides an excellent base for any type of "finish" paint coating.

DOLOMITE HANDLER

Dol mite for open hearth furnace linings is being poured from a new 815 cu ft capacity welded steel transfer bin into a dolomite machine that will feed the stone into the furnace. Blaw-Knox Co. designed and built both the bin and the machine. Now in use in an eastern steel plant, the bin eliminates transporting the machine itself to the dolomite storage area for refilling. Both bin and machine are crane-handled.



POSITIONING SYSTEM

△ CDC Control Services, Inc., has developed a new automatic point-to-point positioning system with simple dial-set analog programming.

Designed principally for automating short-run production in such operations as punching, drilling, inserting, etc., the system offers a distinct time-saving advantage to its use of direct, uncoded programming for repetitive and symmetrical motion patterns. For example, a setup involving five different dimensions and three different repeat commands can be programmed by setting eight adjustment dials. Should variations in dimensions or sequence be required, they can be made immediately by resetting dials.

Positioning is accomplished by means of high-performance electro-hydraulic servo systems, which are capable of a positioning speed of 0.2 sec per basic motion, with positioning accuracy of 1 part in 1000. Because a modulated rather than an on-off signal is used, infinite adjustability is attainable for longitudinal and transverse axis movements. This system is also available for random-instruction (nonrepetitive) or contour programming.

METAL-ROLLING MOTOR

△ The Large Motor & Generator Dept. of General Electric Co. announces a new standard metal-rolling-mill motor line designed to meet the requirements of modern mill practice.

The standard motor is in accordance with NEMA Standards, both 40 and 50 C ratings, is forced ventilated and is furnished with Class B insulation throughout. Quick removable covers provide enclosures on both ends. The re-design, which includes both electrical and mechanical elements of the motor incorporates a number of innovations for greater ease of maintenance as well as increased dependability. Some 40 special design, performance and maintenance improvements have been incorporated in the main drive motors.

The new arrangement of twin-drive motors for reversing hot mills is an example of product re-design which drastically cuts maintenance. Previously the twin-drive motors had the upper motor away from the mill with an extension shaft over the lower motor. For maintenance purposes the extension shaft had to be removed for access to the lower motor, and one of the two thrust bearings was difficult to reach.

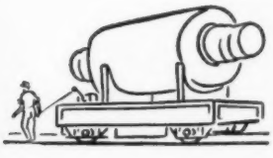
The new standard GE twin-drive has the upper motor located near the mill with the lower motor set back. The extension shaft, located beneath the upper motor, can be removed toward the mill, and both thrust bearings are equally accessible. This new "Top-Forward" arrangement has been applied to eleven new twin-drives in the past two years.

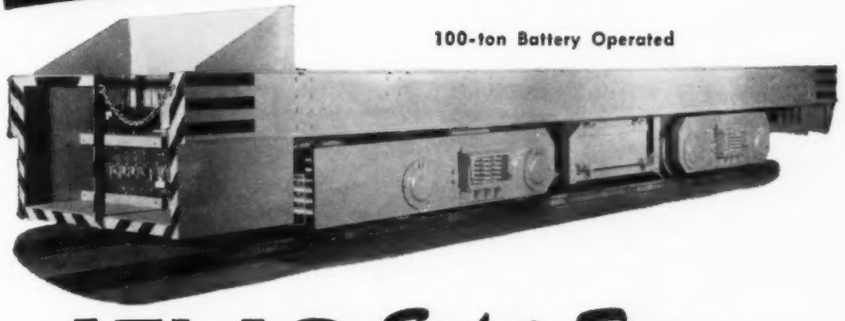
The use of forged-flange couplings with their smaller diameters has made the new arrangement practical. The coupling which is forged as an integral part of the shaft is inherently stronger as a homogeneous structure and eliminates the stress concentration of a keyway.

Quick removable covers over both ends of the new motors provide almost immediate access to the motors. All cover bolts have been eliminated so that the cover can be removed in the time it takes to attach the crane cable to its lifting eyes.

The rotor coil insulation is field-proven mica mat insulation with

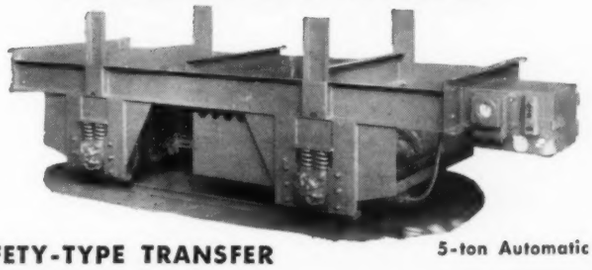
HANDLES THE BIG LOADS WITH BIG SAVINGS





100-ton Battery Operated

ATLAS *Safety Type* TRANSFERS



5-ton Automatic Controlled

ATLAS SAFETY-TYPE TRANSFER CARS can be provided in almost any capacity for storage battery, diesel or gas-electric, or cable reel service.

They are safe because there is only one control lever, and the car moves only when the operator holds the lever.

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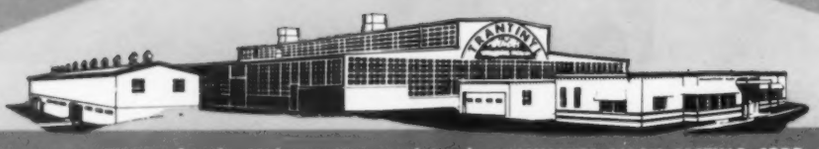

Sole Licensee to cast "TRANTINYL" for the Midwest, West and South: WAUNAKEE ALLOY CASTING CORP., Waunakee, Wis.

glass tape slot armor. To protect these basic insulating materials from the ravages of foreign matter, the system has been improved by impregnating the insulation with a newly developed solventless thermosetting resin.

The stator insulation has been improved by the use of high-temperature-resisting resins. After the coils have been assembled in the machine, the entire windings are immersed several times in a high quality varnish whose color was selected to reveal any dirt accumulation. This insulating varnish protects the finished windings from moisture and dirt and has been proven by field tests. The color system should assist in determining the proper time to clean the machine.

Constant-pressure brush holders are standard for both nonreversing and reversing motors. These holders maintain correct brush pressure at all times so that the need to adjust brush pressure is eliminated. The brushes and brush holders are designed to visually indicate the proper time for replacement.

All steel self-locking nuts and bolts are utilized in the interior of the motor to fasten components that might be loosened by vibration. Inspection lights and utility outlets are conveniently located inside the motor. This provides a power source for hand tools eliminating the bother of obtaining temporary lighting and power. The painting of the complete interior of the machine is such as to reflect the maximum amount of light making inspection easy.

Integral ventilation of mill motors is available as a standard modification. An integral ventilation system; including blowers, filters and coolers; can save on installed cost and results in reduced maintenance costs.

EXCESS AIR GAS BURNER

△ A new excess air gas burner for sealed-in firing in industrial furnaces, kilns and other heat processing equipment has been developed by Hauck Manufacturing Co. The burner produces an exceptionally stable flame even with 1000 per cent or more of excess air.

Because of the greater forward velocities of hot combustion gases, a better distribution, circulation and penetration of heat is effected. Excellent control of flame temperature

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Here is a rugged and durable television system built especially for industrial use. It gives years of satisfactory service under the most difficult conditions industry has to offer . . . and with minimum attention. Diamond television systems installed as long ago as 1947 are still in operation.

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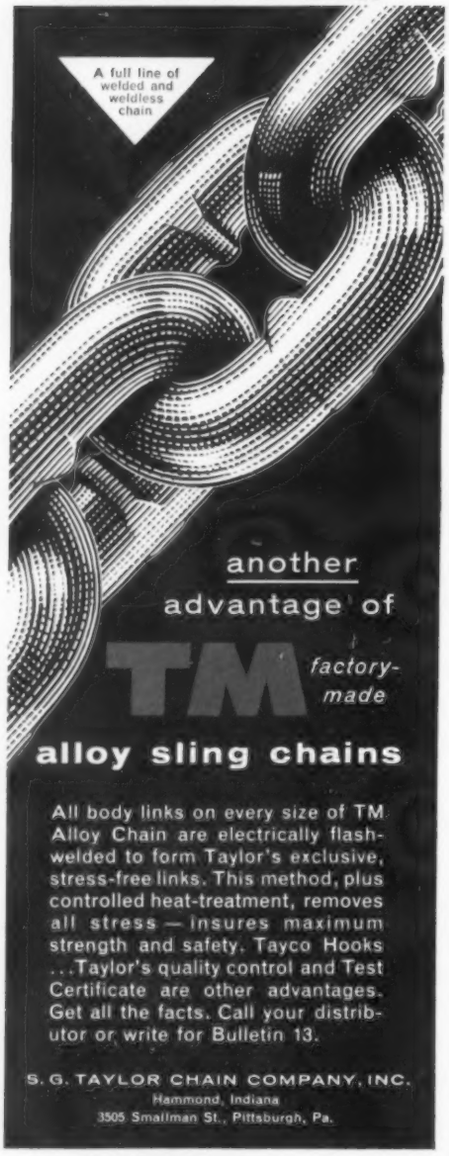

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TM factory-made

alloy sling chains

All body links on every size of TM Alloy Chain are electrically flash-welded to form Taylor's exclusive, stress-free links. This method, plus controlled heat-treatment, removes all stress — insures maximum strength and safety. Tayco Hooks ...Taylor's quality control and Test Certificate are other advantages. Get all the facts. Call your distributor or write for Bulletin 13.

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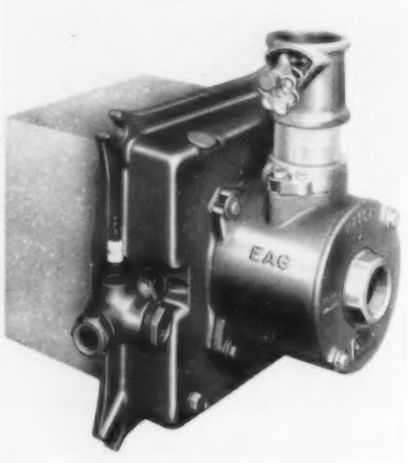
Taylor Made CHAIN SINCE 1873

and dependable operation are obtained with either large or small amounts of excess air. Stratification of hot gases is minimized, and development of localized hot spots is eliminated. Fewer burners are needed. Ignition is positive and easy at any burner setting on hot or cold furnaces. A continuous pilot is not



required. There is no burner flashback.

Maximum flame safety protection can be applied since the burner design permits the rise of either pilot protection or main flame supervision or both when desired.

The burner nozzle and body are made of heat-resistant alloy; the tile is a super refractory. These are set in a box-type mounting plate with the "Wedge-Grip" tile locking device holding the burner tile and plate in alinement. The entire assembly can be installed with the air inlet at any one of four 90 deg quadrants.

TUBE TYPE MOTORS

△ Tube type, totally enclosed, fan-cooled, squirrel-cage motors are offered in polyphase ratings through 500 hp. by Wagner Electric Corp.

Efficient cooling is provided in these fabricated steel frame motors by a series of tubes through which outside air is forced by an external blower. An internal blower at each end of the rotor circulates the warm air inside the motor through ducts in the rotor and stator and around the cooling tubes.

Standard enclosed motors are built with Class A insulation for

(*Plese turn to page 218*)

THE ENGINEERING MART

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POSITIONS VACANT
POSITIONS WANTED

AN *IRON and STEEL ENGINEER* SERVICE TO THE STEEL MILL OPERATORS

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For new steel mill now being constructed in the Valley of the Sun, near Phoenix, Arizona. Need man fully qualified to supervise mill with electric furnaces, blooming mill and bar mill to produce full range reinforcing bars, merchant bars and light structurals. Send resume with availability and salary requirements to Western Rolling Mills Division, Yuba Consolidated Industries, Inc., 1008 Professional Building, Phoenix, Arizona. All replies strictly confidential.

THE COST OF AN AD THIS SIZE IS $8.00 PER INSERTION

Equipment News

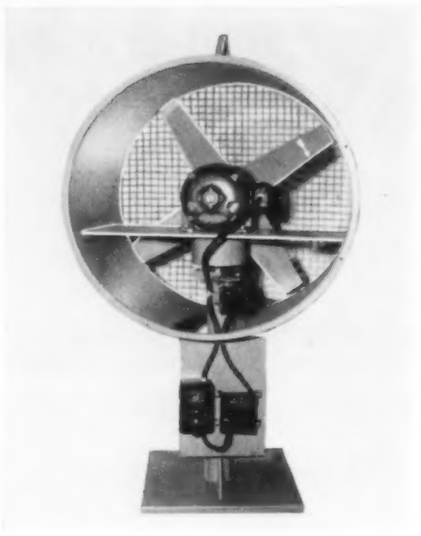
(Continued from page 216)

55 C rise or with Class B insulation for 75 C rise. Explosion-proof motors are built with Class A insulation only and have Underwriters' Laboratories approval for operation under classified hazardous conditions. Motors can be supplied bearing labels for Class I, Group C and D or Class II, Group E, F and G locations.

OSCILLATING FAN

△ Robinson Ventilating Co. has announced a new heavy duty industrial "man cooler" oscillating fan.

The new fan features a gearmotor



drive with positive oscillating movement, that covers twice the area of a single stationary fan. This results in space and power savings. Of rugged steel construction, it is electrically welded throughout.

Totally enclosed in heavy duty wire mesh for safety, the new fan is available in blade sizes from 30 to 42 in. and in $1\frac{1}{2}$ to $7\frac{1}{2}$ hp.

Book Reviews

"Dispersion of Materials," by Rolt Hammond, has been published recently by the Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. The book contains 230 pages, 6 x 9 in., is cloth bound, and sells for $10.00. The first two chapters of the book deal with the principles and practice of crushing, grinding and classifying materials, including special methods needed for the processing of very hard ones and other difficult materials. Subsequent chapters deal with the very important subject of fluidization with its industrial applications, its advantages and its limitations; flotation, including froth flotation; liquid dispersions, including solutions, emulsions, emulsoids, gels, coagulation, homogenization, etc.; and also the dispersion of gases and atmospheric pollution. It includes information on the nature of smoke and the cause of pollution, the treatment of gaseous effluents, gas washers, dust collection, acid mists, electrical resistivity of dust and all other aspects of this important subject. The text is amply illustrated with line drawings, equations and photographs.

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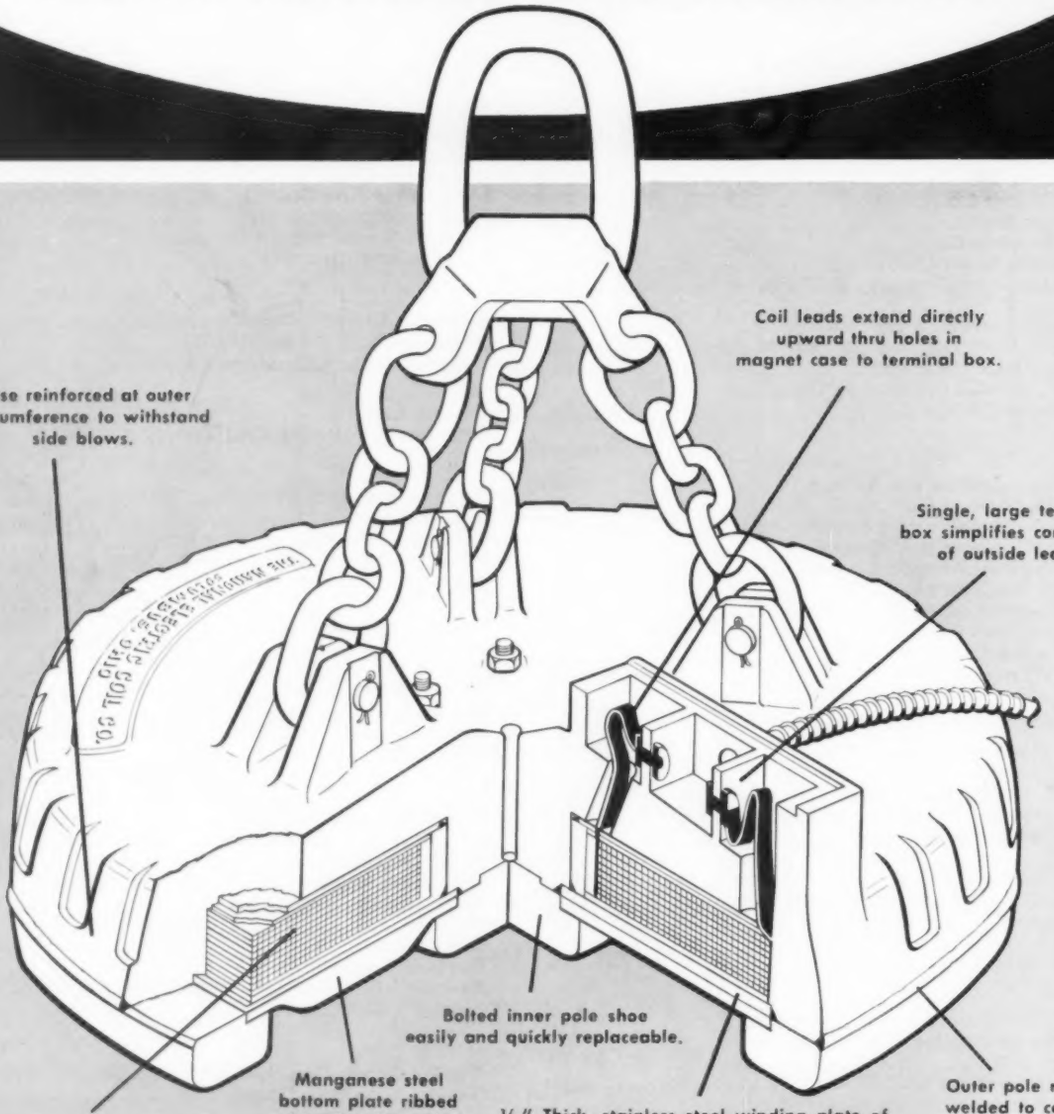
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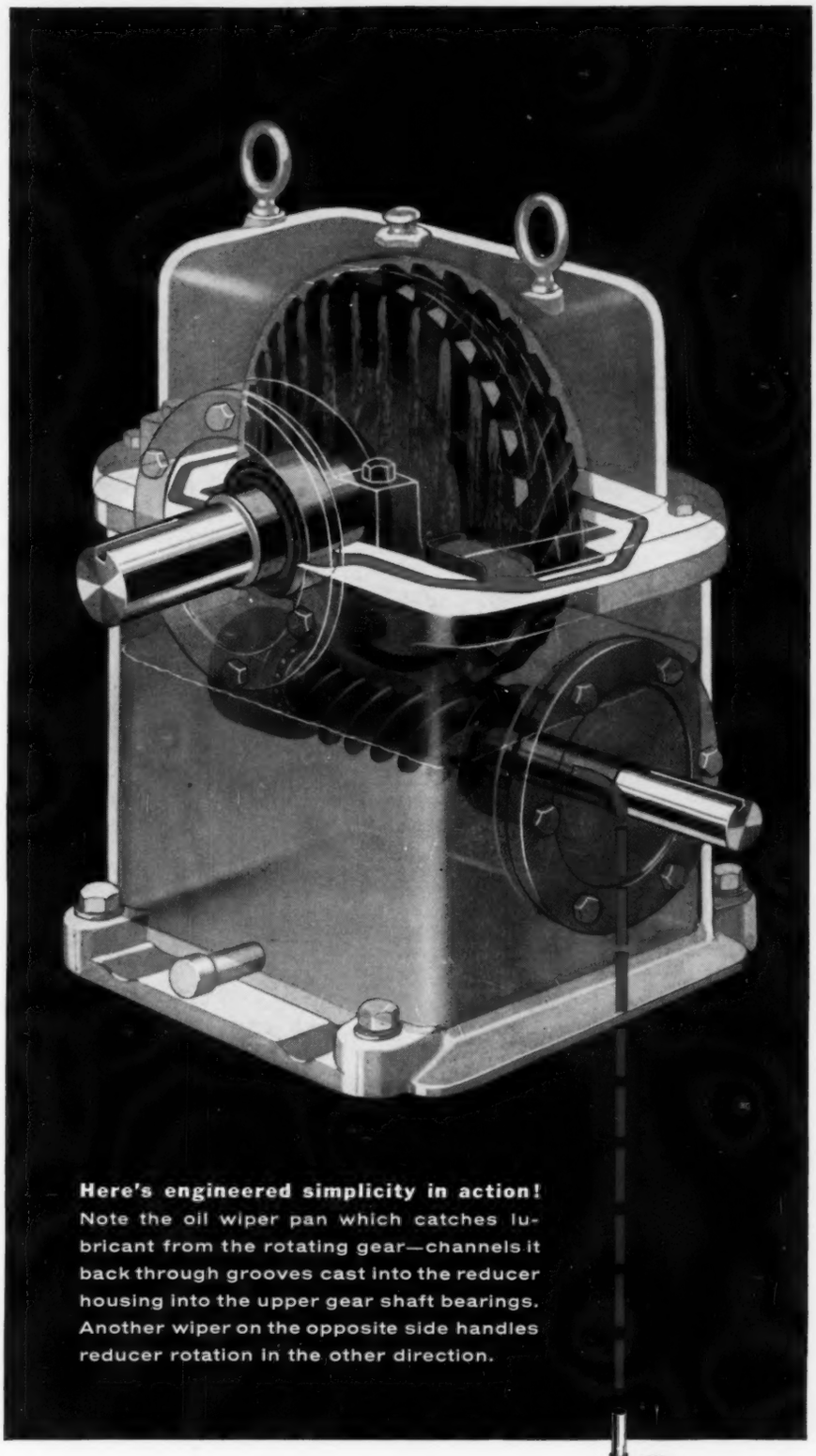

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